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JOURNAL

VOLUME 13, NUMBER 11 • NOVEMBER, 1957

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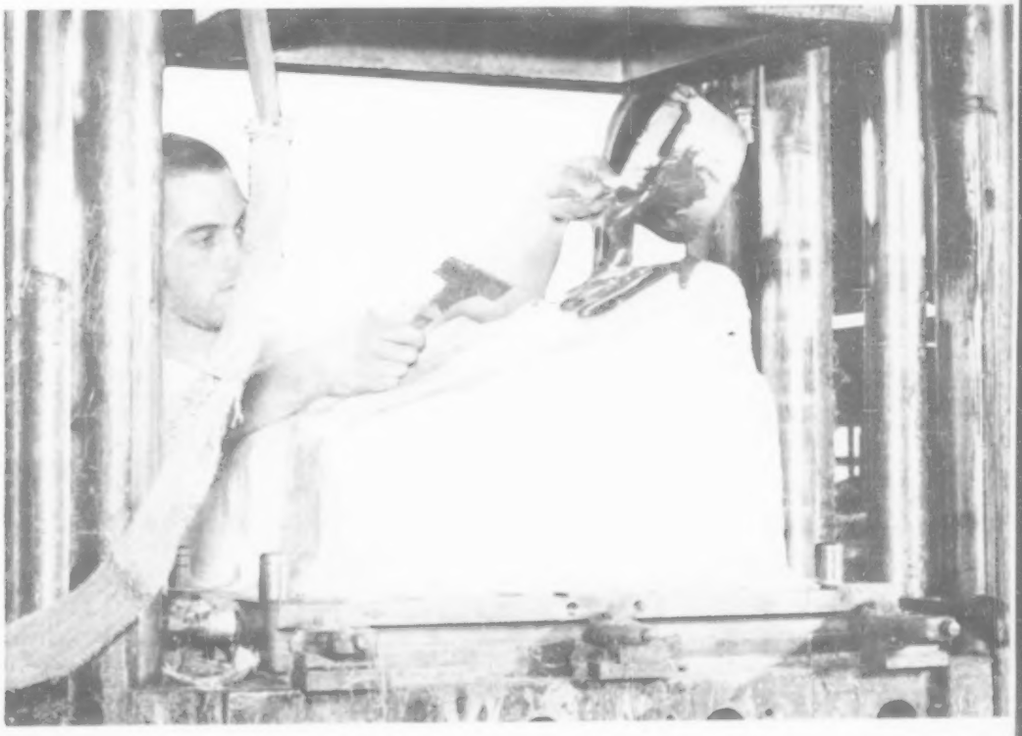
Reinforced Plastics Cash Register



PUBLISHED BY THE SOCIETY OF PLASTICS ENGINEERS, INC.

Watson-Stillman Press Division is moving to Rochester

EFFECTIVE NOVEMBER 1, 1957, the engineering, sales and service headquarters of the Watson-Stillman Press Division, Farrel-Birmingham Company, Inc., will be located at the company's modern plant in Rochester, New York.

One of the finest, large machine-tool building facilities in the country, the Rochester plant has 10 acres of plant floor space and 21 acres of yard and open storage; complete, modern machine shops with over 50,000 square feet of erecting space; and spacious office facilities.

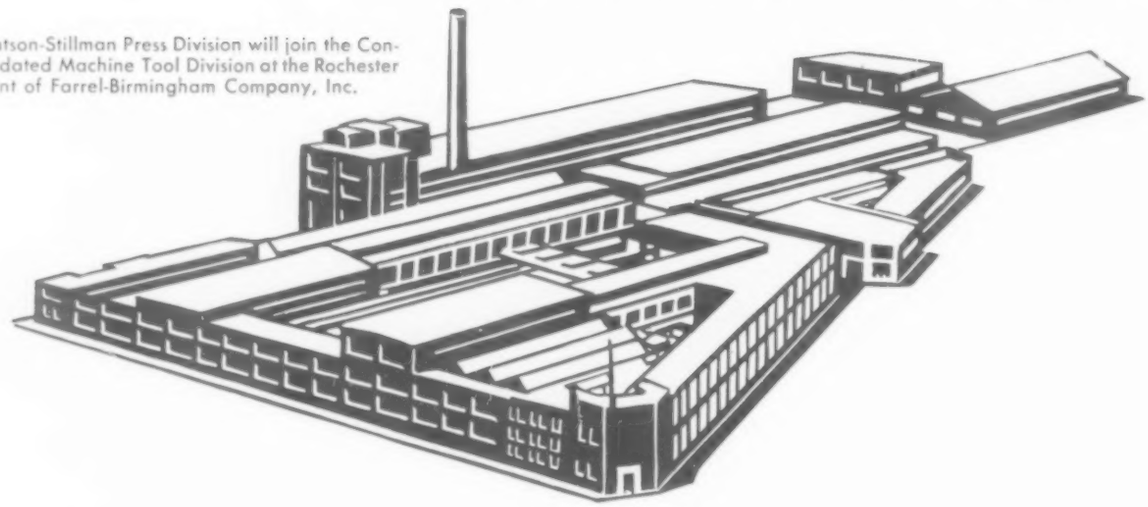
Manufacture of Watson-Stillman plastics injection, compression and transfer molding machines will be concentrated at the Rochester and Buffalo plants. With our headquarters closer to our manufacturing sources, you are assured of materially improved service in the future.

New Address:

WATSON-STILLMAN PRESS DIVISION
FARREL-BIRMINGHAM COMPANY, INC.
565 Blossom Road, Rochester 10, New York
Telephone: BUtler 8-4600

WATSON-STILLMAN®

Watson-Stillman Press Division will join the Consolidated Machine Tool Division at the Rochester plant of Farrel-Birmingham Company, Inc.



WS-39

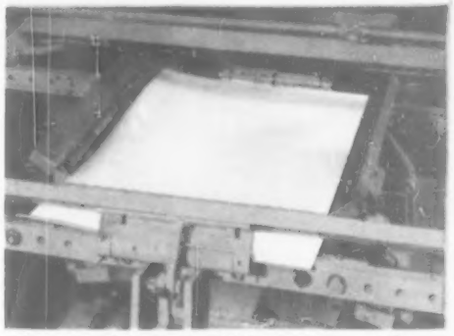
A TECHNICAL REPORT FROM DU PONT

Advantages of

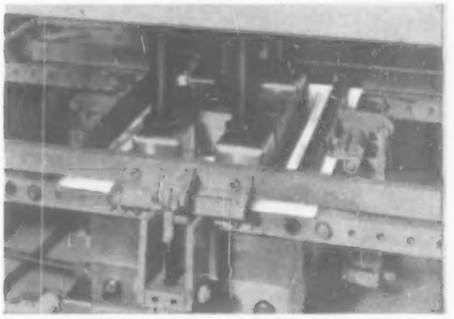
ALATHON® 31

POLYETHYLENE RESIN

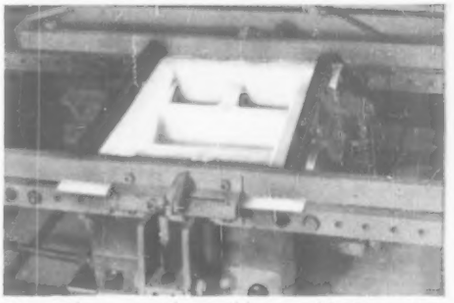
for thermoforming



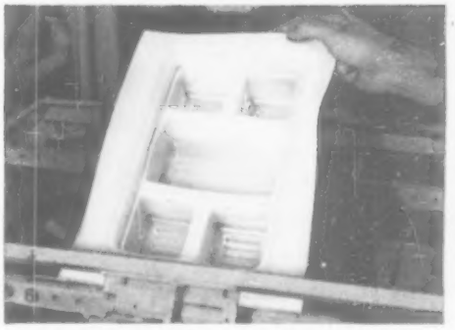
Sheeting of ALATHON 31 in position on clamp frame prior to heating process.



Heated sheet is pushed into mold cavities by forming assist plugs, then drawn off plugs and against mold-cavity surface by vacuum.



Formed piece cools quickly in mold after assist plugs have been raised.



Piece is removed from forming machine and ready for trimming.

● ALATHON 31 is a pure polyethylene resin of high density, low melt index, and narrow molecular weight distribution. Designed by Du Pont specifically for the extrusion of heavy sheet used in thermoforming, ALATHON 31 is unexcelled for items formed from sheet material.

Since ALATHON 31 is designed to be very viscous in the molten state, it overcomes the problem of sag during the heating step prior to thermoforming. This high viscosity, however, presents no problem in the manufacture of the sheeting, or in the forming of the sheet. Tailor-made to provide the optimum combination of stiffness, extrudability, minimum sag at forming temperature, minimum cooling time in the mold, and the ability to conform to the detail in the mold cavity, ALATHON 31 opens a new approach to the manufacture of all kinds of packages, housewares, toys, laboratory equipment and similar products. Mold temperatures approaching 190°F. may be used with ALATHON 31 with little increase in cooling time on the mold. Advantages of high mold temperature are less likelihood of mark-off and improvement in stiffness.

The greater stiffness of ALATHON 31 can be used to enhance the final molding, or it can be used to lower costs by reducing the wall thickness of the object. ALATHON 31 provides attractive glossy surfaces and is exceptionally resistant to environmental stress cracking. Because it is virgin polyethylene, ALATHON 31 is free from taste and odor, and is completely non-toxic. For more property and application data on this unique new resin, simply clip and mail the coupon below.

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Room 4511, Du Pont Building, Wilmington 98, Delaware

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*Company*_____

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IN CANADA: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec

U.S.I.

Vol. II, No. 6

POLYETHYLENE PROCESSING TIPS

RESIN PROPERTIES THAT AFFECT STRESS-CRACK RESISTANCE OF POLYETHYLENE

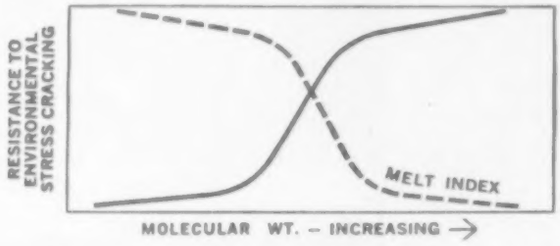
Environmental stress cracking is the term used to describe a certain type of material failure. With polyethylene this failure occurs when the plastic is under high local stress (either external or internal) and in contact with materials such as a soap, detergent, or solvent, which affects the polymer.

Resistance to stress cracking is especially important for applications such as electrical insulation, polyethylene pipe, housewares, and certain types of packages.

Two factors influence the resistance of a polyethylene part to environmental stress cracking: the resin used and the conditions used in fabricating the part.

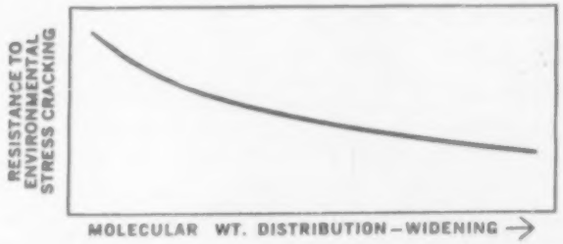
Which resin to use:

Stress crack resistance is greater with a resin of ***higher molecular weight*** – that is, lower melt index.



Then why not use low melt index resins? Because production rates are lower. The processor must make a compromise between peak production rate and top stress-crack resistance and use a resin that will be satisfactory, if not ideal, in both respects.

Molecular weight distribution of the polyethylene resin is important too. Resins with a narrow molecular weight distribution (with fewer molecules much higher or lower than the average) have better stress crack resistance than those with wide molecular weight distribution (more of the larger and smaller molecules but the same average). The low molecular weight fraction is more susceptible to attack by environmental materials.



However, the flow properties of a polyethylene resin having a narrow molecular weight distribution and a given melt index are not as good as those of a polyethylene resin having a wide molecular weight distribution and the same melt index. Here again the processor must make a compromise between production rate and the properties he requires in the end product.

Density of the resin will also have an effect on the resistance of that polyethylene resin to environmental stress cracking. The higher the density, the poorer resistance to environmental stress cracking. On the other hand, the more linear or more dense polyethylenes have enhanced flow properties and higher stiffness and tensile strength.

There is no single answer to all problems

It is obvious from the preceding discussion that there is no simple solution to the selection of a resin for a particular end use. The resin must be carefully selected while giving proper consideration to the important end properties required in the fabricated article.

An answer to your particular problem can be found by obtaining a polyethylene resin from a manufacturer who can give you the balance of properties required – high or low melt index, narrow or wide molecular weight distribution, a range of densities. U.S.I. is one such supplier and their Technical Service Representatives stand ready to assist you in the selection of the proper Petrothene resin.

Processing conditions affect stress crack resistance

Processing temperatures, cooling rates, and other processing conditions can have a marked effect on stress crack resistance, because of residual strains left in the fabricated article.

There isn't room to go into these in detail here but the next issue of "Tips" will discuss them more fully.

Meanwhile if you have a specific problem, call on U.S.I.'s Technical Service Engineers. They will be glad to work with you toward finding a solution.

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SPE JOURNAL

VOL. 13 NOVEMBER, 1957 NO. 11

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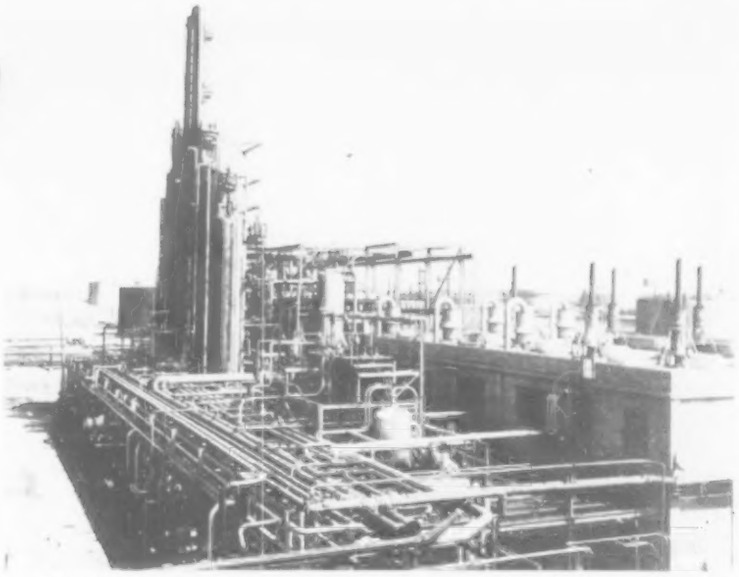

Facilities for production of Emulsifiable A-C Polyethylene 629 at the Buffalo, New York plant of the Semet-Solvay Petrochemical Division, Allied Chemical & Dye Corporation, have been greatly expanded. This plant produces low molecular weight A-C Polyethylene in hot melt and emulsifiable grades.

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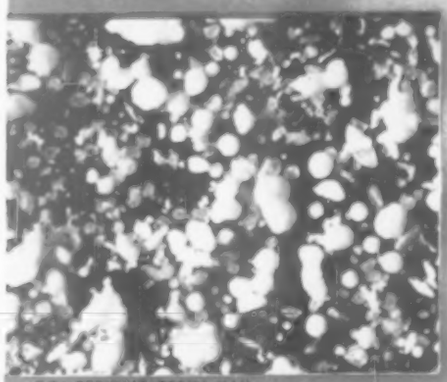
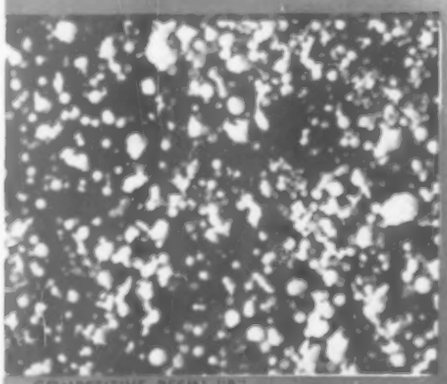


COMPETITIVE RESIN "A"



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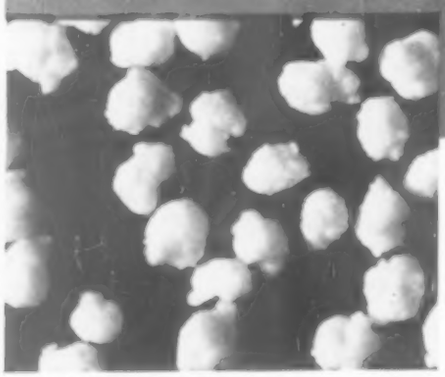

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From The Editor's Notebook

By JESSE H. DAY

Peter W. Simmons, National President, announces the appointment of Thomas A. Bissell as Executive Secretary of the Society, effective November 11, 1957. (Story on page 53.)

• **Plastic** or **Plastics?** This is the question we are asked by libraries, magazines and members. Pros and cons come to us along with the questions about a dozen times a year—and this has been going on for more than a decade.

Here's the problem; "plastic" is an adjective rightly used for such things as clay and steel—anything deformable by pressure; it is also a noun specifically referring to the substances of interest to SPE members. "Plastics" is more than the plural of "plastic"—it is sometimes used as a singular word referring to an item made of one or more plastic high polymers.

While each man's usage seems clear and unambiguous to himself, there are all shades of opinion as to what usage is really correct.

We therefore suggest—until convinced otherwise—that the following usages be considered correct:

"Plastic"—as an adjective, meaning deformable by heat and or pressure.

"Plastics"—as an adjective, modifying a noun which encompasses the field of plastic high polymers. Example "plastics engineer" or "plastics industry."

"Plastic"—as a noun, to refer to a single kind of plastic high polymer. Strictly speaking a "plastic toy" could be made entirely of steel or even glass—but the common use of "plastic" as the name of a kind of material is so much more widely understood than "plastic" as an adjective, that we shall have to accept it,—and the possible rare misunderstandings.

"Plastics"—as a noun, to refer to the field of all plastic high polymers, with whatever adjective may be needed to delimit the area of reference, as "inorganic plastics."

Best reference for our remembering—we are The Society of Plastics Engineers.

Calendar of SPE Technical Meetings

ANNUAL TECHNICAL CONFERENCE

"Progress Through Plastics Engineering"

January 28-31, 1958 — Detroit

The Hotel Sheraton-Cadillac

—96 engineering and scientific papers on all phases of the plastics industry, including research and education —

Chairman: C. H. Whitlock, 21655 Coolidge Road, Oak Park, Mich.

—Session Moderators listed on page 54—

This Month's Cover:

This month's cover shows resin being poured over reinforcement—object in this case is to make a cash register housing. If you want to know how it's all done, turn to page 29.

COMPLETE SERVICE FOR THE PLASTICS EXTRUSION INDUSTRY

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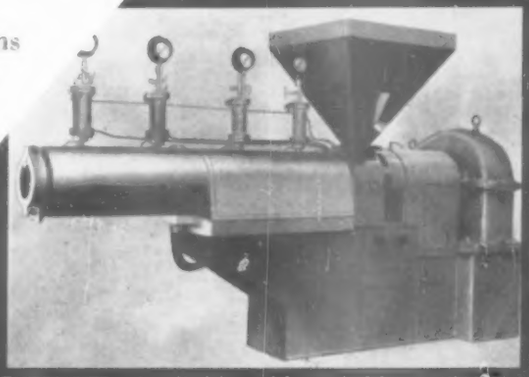

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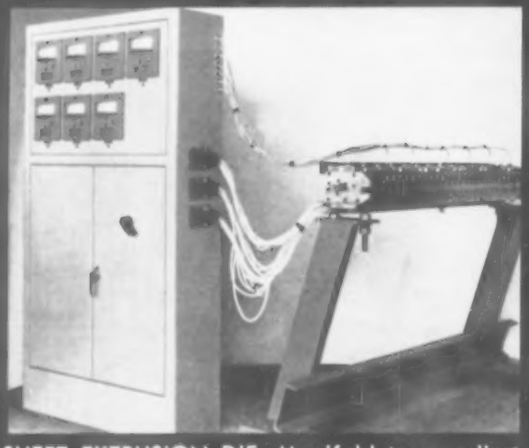

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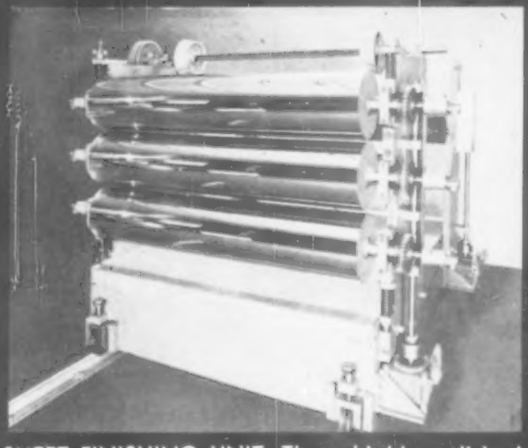

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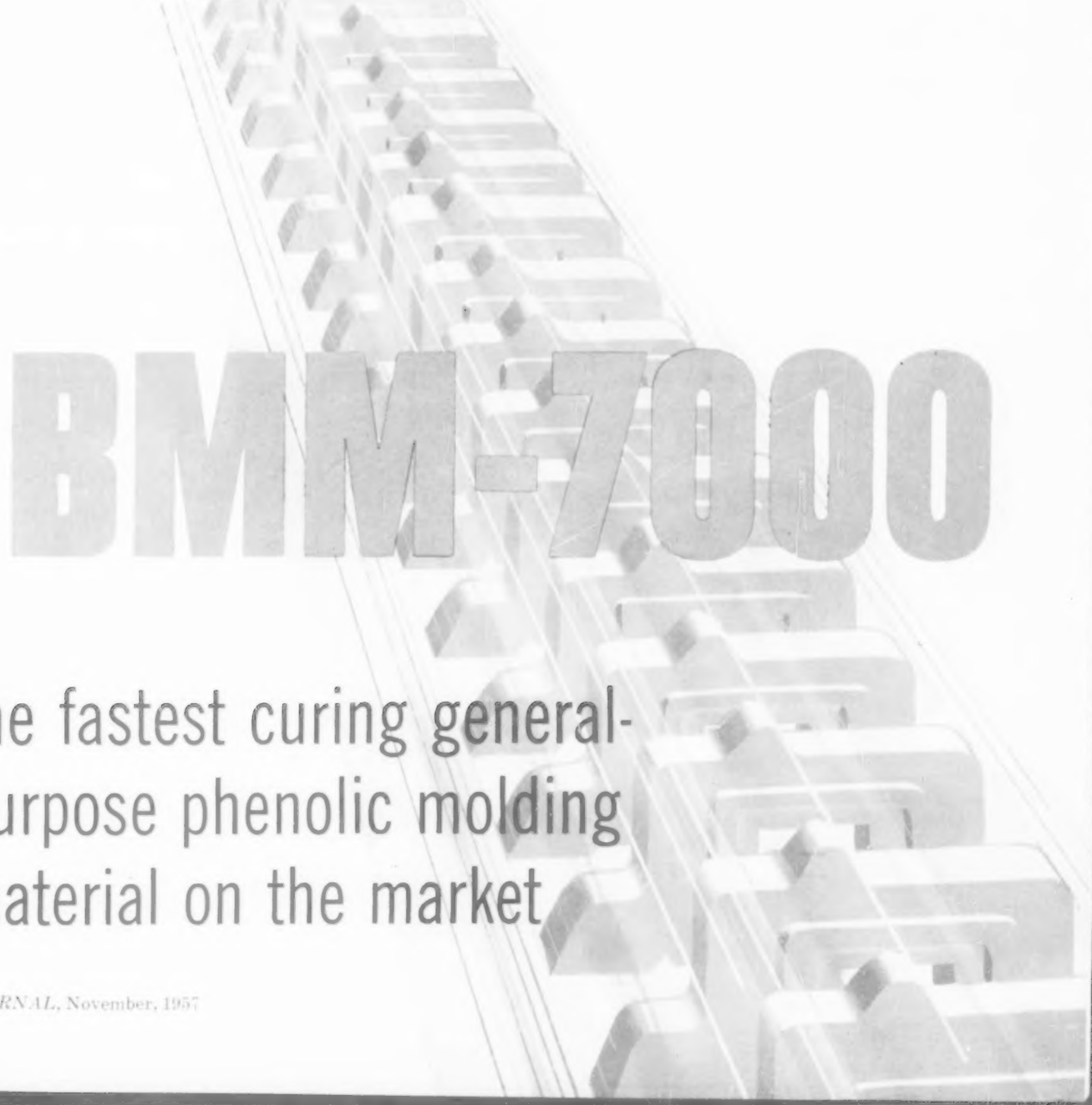

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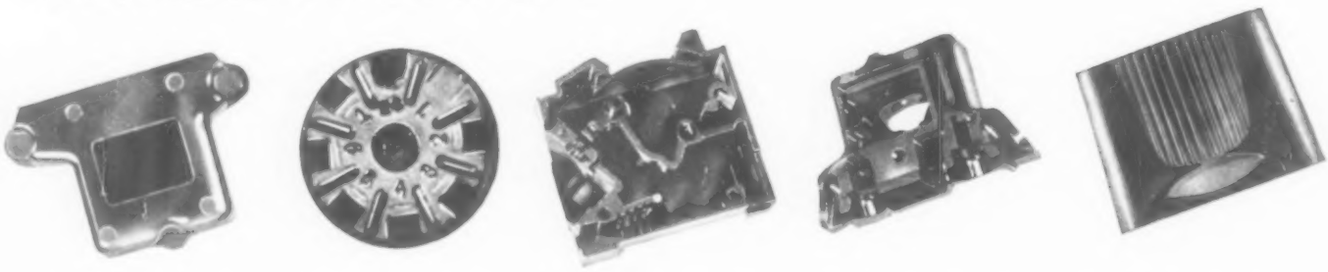

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Small electrical parts molded of BMM-7000 show its fidelity to mold details, its surface gloss, and its suitability for complex mold designs, all with the added advantages of wide molding latitude and fast production rates.

*Compared to previously used material

cures faster than any other general-purpose phenolic...

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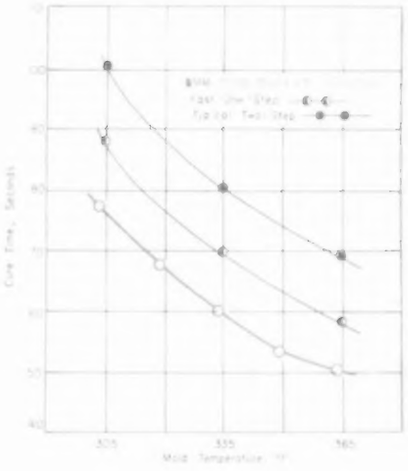
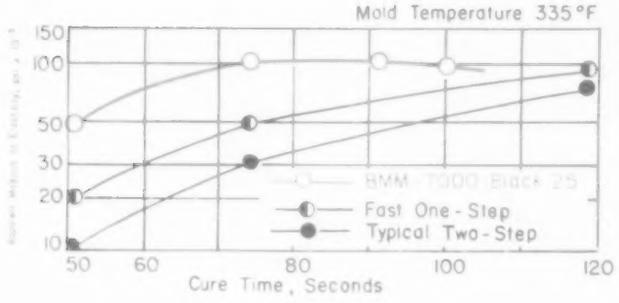
...a general-purpose two-step wood-flour filled phenolic molding material. Its cure speed is exceptional—faster than either two-step or very fast one-step materials. Intended for cold powder automatic molding, BMM-7000 can also be plunger molded on fast cycles.

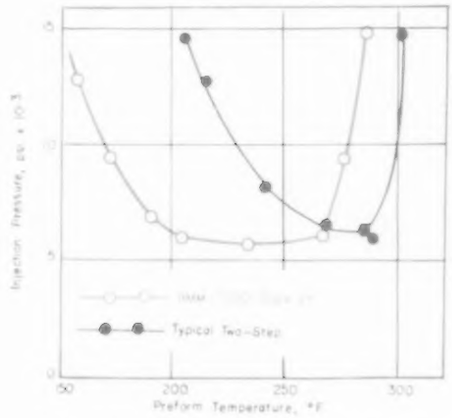
FAST CURE SPEED—BMM-7000 cured as fast at 315 deg. F. as a fast one-step material at 335 deg. F., and a two-step material at 365 deg. F., according to a test of minimum blister-free time in cold powder compression molding.



HOT RIGIDITY—BMM-7000 took 50 seconds to reach an apparent modulus of elasticity of 50,000 psi at 335 deg. F. A fast one-step phenolic took 50 per cent longer, a typical two-step material, 100 per cent longer.



MOLDING LATITUDE—As determined by plunger molding, BMM-7000 could be preheated over a wider range than general-purpose BMG-5000, and still give mold fill-out—an 87 deg. F. spread at 7500 psi, compared to 46 degrees for BMG-5000. This property makes the new material suitable for molding large pieces even with its fast cure speed.



IN ADDITION—BMM-7000 demonstrates good mold release, freedom from mold staining, low specific gravity, and low shrinkage.

TYPICAL TEST VALUES OF BAKELITE BRAND GENERAL-PURPOSE PHENOLIC COMPOUND BMM-7000

BMM-7000 BLACK 25
TYPICAL TEST VALUES

VALUES RELATING TO FABRICATION

Granulation (D392-38)	12 mesh*
Bulk Factor (D392-38)	2.3
Tabletting Qualities	Easily preformed on standard equipment.
Pourability (D392-38), sec.	19
Plasticity Grades Available	6, 9, 12
Molding Shrinkage (D955-51), in./in.	0.004

*All grades supplied in special low fines granulation.

VALUES FROM ELECTRICAL TESTS

Dielectric Strength (D149-55T)			
Short time, volts/mil	330		
Volume Resistivity (D257-54T)			
ohm-cm	6×10^{12}		
	60C	1 KC	1 MC
Dielectric Constant (D150-54T)	6.1	5.7	4.6
Dissipation Factor (D150-54T)	0.08	0.04	0.03

VALUES FROM MISCELLANEOUS TESTS

Molded Specific Gravity (D392-38)	1.36
Heat Distortion Temperature (D648-45T) deg. F.	330
Water Absorption (D570-54T) % wt. gain	0.5

VALUES FROM MECHANICAL TESTS

Izod Impact Strength (D256-54T) (Ft. lb./in. of notch)	0.29
Compressive Strength (D695-54), psi	35,000
Tensile Strength (D651-48) (⅛"), psi	6,900
Flexural Properties (D790-49T): Flexural Strength, psi	9,000
Modulus of Elasticity in Flexure, psi	9.5×10^5

WRITE FOR MORE FACTS... TEST IT YOURSELF!

Molders who have already tried this new general-purpose phenolic have found it an impressive time-saver. Find out for yourself,—try it in your own operations. Write for complete data and samples to Dept. AG-171.

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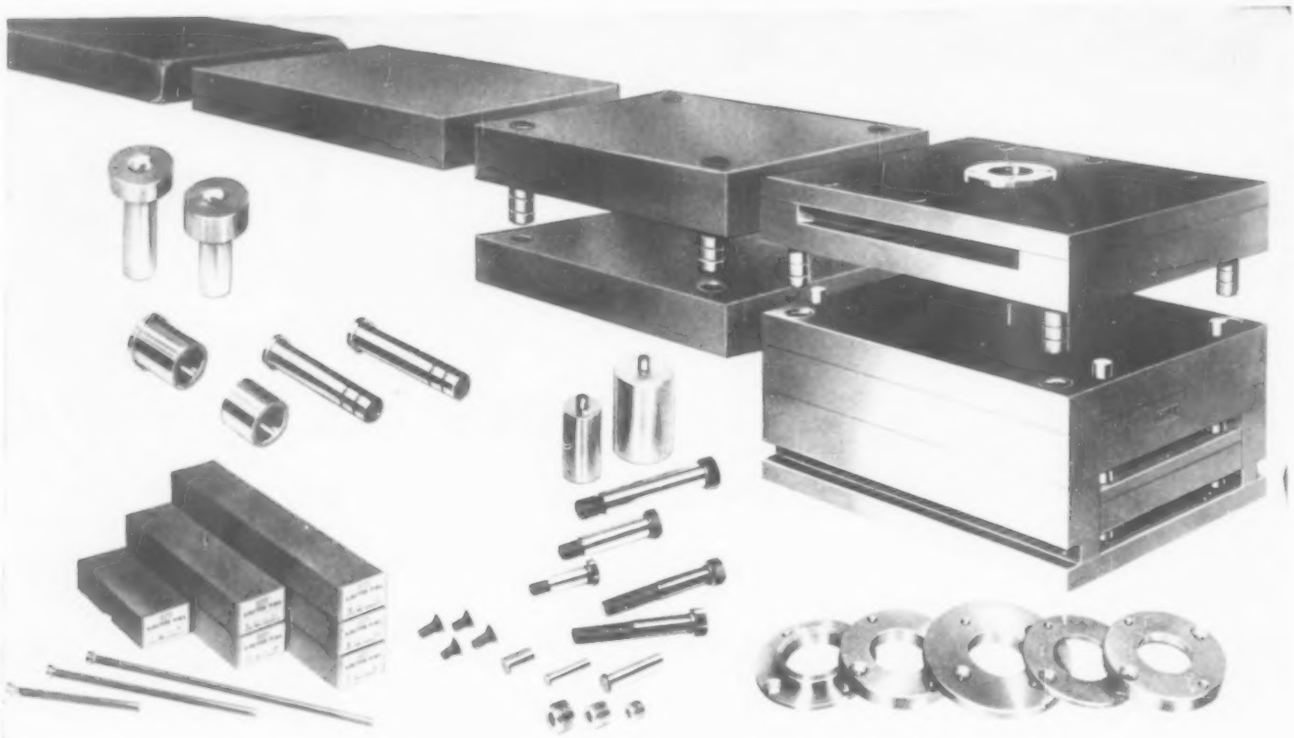

PROGRESS THROUGH STANDARDS

. . . and how DME "helped"

The history of economy in modern business has been directly related to the history of Standardization. One of the major elements affecting the economic production of finished plastic parts is the high initial cost of the mold. A progressive step in reducing mold cost, without sacrificing the high quality required, has been successfully achieved through Standardization.

When D-M-E originated Standard Mold Bases and their component parts in 1942, it provided the answer to the rapidly growing demand for high quality molds that would maintain and promote the economic advantages of plastic parts.

Through large volume purchases of quality steel in standard sizes and specialized production facilities, D-M-E was able to produce and supply high quality Standard Mold Bases to mold makers and molders at such great savings in cost and time that the benefits of Standardization were quickly realized by the Industry.

Today D-M-E produces twenty-eight different sizes of Standard Mold Bases, from 9" x 8" to 23¾" x 35½", in either D-M-E No. 1 or No. 2 Steel, with a wide range of cavity plate thicknesses to satisfy the diversified demands required. In addition, over 2,000 finished component parts of the same high quality are available to provide additional savings in service as well as in the product.

Properly engineered Standardization puts the accent on Economy. When you "Specify D-M-E . . ." you get Quality, Service AND Economy!

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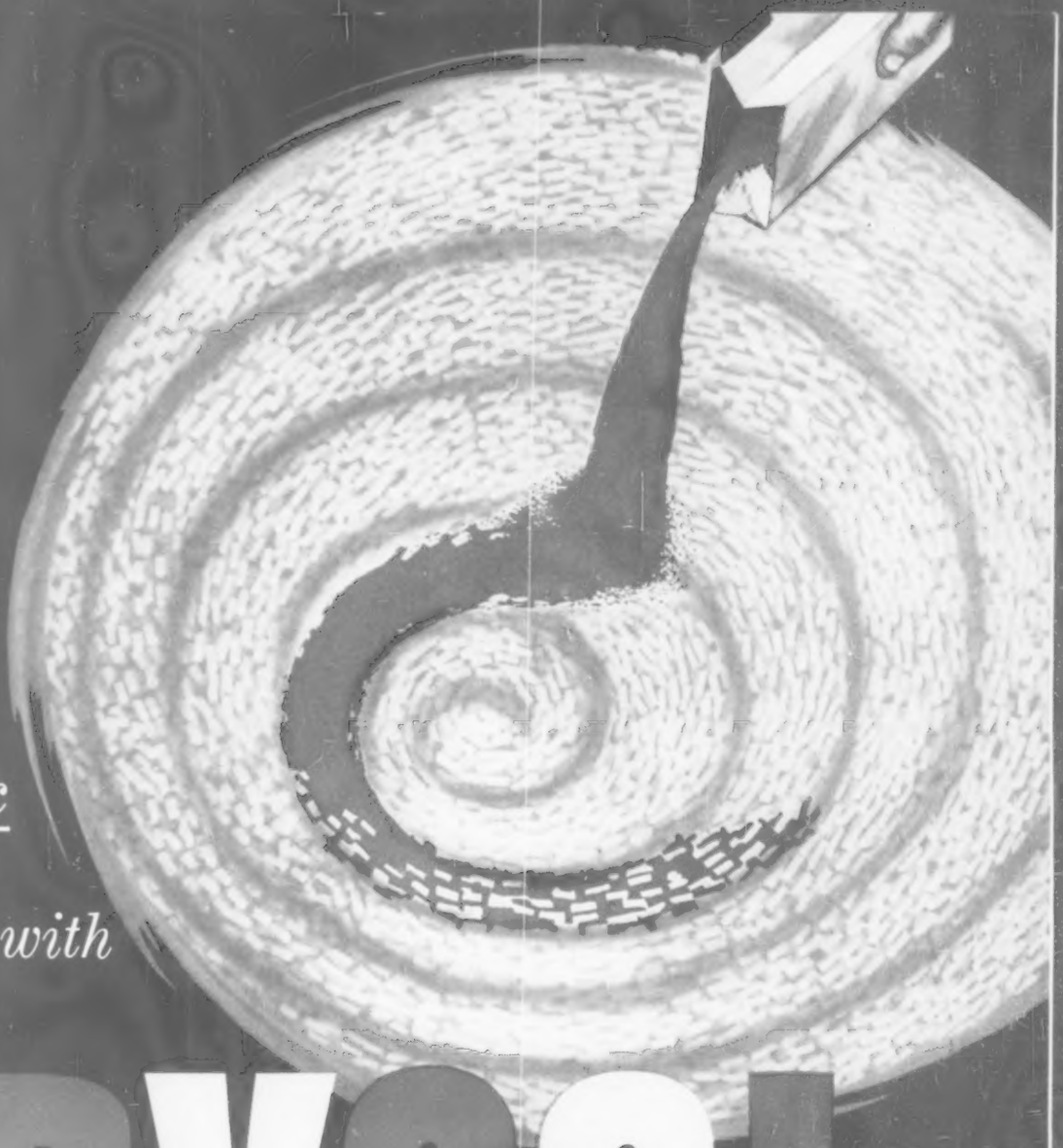

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"DRYCOL" is conveniently packaged in pre-weighed units for ready blending with all thermoplastics. It is also supplied in bulk to give the molder greater savings and added flexibility in production scheduling.

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From a specially developed Monsanto vinyl paste resin, *Opalon 110*, come the finest vinyl plastisols. And from these colloidal dispersions of vinyl resin in plasticizers, come permanent and resilient finishes for metals, coated fabrics and paper for quality luggage, flooring and upholstery . . . slush-molded rain boots and dolls' heads . . . cast packaging films . . . foams for insulation and sound-proofing . . . caulking compounds and sealants.

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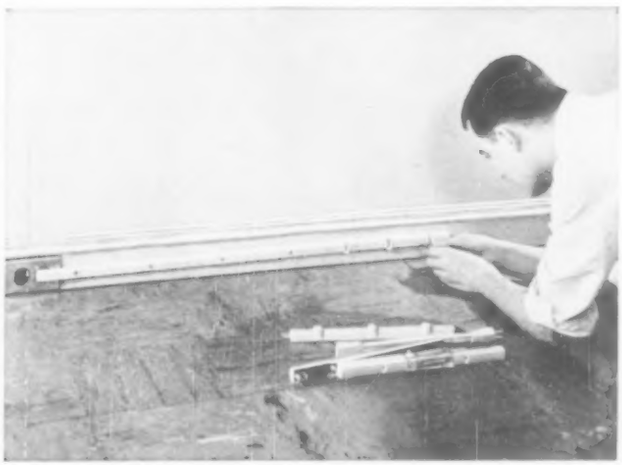
CYANAMID

PLASTICS NEWSFRONT

BABY-FEEDING WARE WITHSTANDS FREQUENT BOILING—AND BABY

Clever design and practical purpose are combined in the attractive baby-feeding ware and educational toys molded by North Star Industries of CYMAC® 400 polymethylstyrene molding compound. Thanks to CYMAC, all pieces are boilable—can be sterilized as often as necessary without distortion, cracking or discoloration. CYMAC upgrades products, provides better quality at competitive cost.



NEW LOW-COST ELECTRICAL OUTLET SYSTEM

Made from ivory-colored BEETLE® urea molding compound, these interlocking foot-long units provide low-cost, easily installed electrical outlets wherever they're needed. BEETLE's strength and excellent insulating properties guarantee safe, dependable service. Its hard smooth surface resists scratching and discoloration. Made by Cable Electric Products Inc., Providence, R. I., this new Snapit Inter-Link system is fully approved by Underwriters Laboratories Inc., a sure indication of its quality and safety.

PLASTIC DESK TOPS HERE TO STAY

"Not a single delamination caused by a faulty glue line" is the proud record of Desk Tops Inc., major supplier of school desk tops east of the Mississippi. URAC® 185 urea resin adhesive is used to bond hardwood plywood cores to rich CYMEL® melamine resin plastic surfaces. These resins are exceptionally strong and are fully resistant to moisture, heat and chemicals. Desk Tops Inc. guarantees tops against glue failure...will use no adhesive other than URAC 185.

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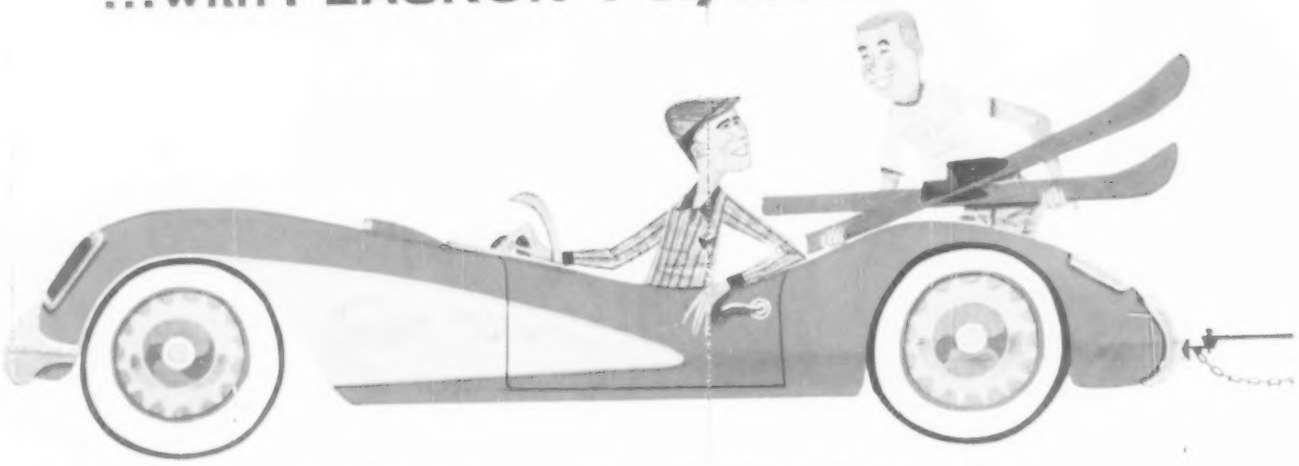
...with PLASKON® Polyesters



No doubt about it, polyesters are really going places—and fast! There are many good reasons for this . . . these versatile materials offer great freedom of design; unique color, translucency and surface effects; and dependable service, to mention only a few. As an example, note the great variety of products pictured above—including laminates, premix parts and polyurethane foams—all made with PLASKON Polyester Resins.

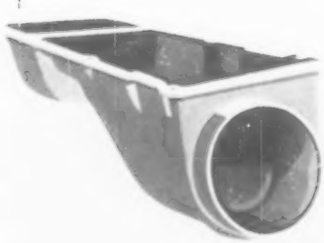
Wherever great strength combined with light weight are primary requirements, especially in relatively large units, PLASKON Polyesters—reinforced with glass fibers or other materials—are likely candidates. Other outstanding advantages: excellent electrical insulation, dimensional stability, a hard, durable surface that resists weathering and chemical corrosion, good colorability—opaque or translucent.

PLASKON Polyesters play a leading role, too, in the booming market for polyurethane foams. Strong, *rigid* foams for thermal and acoustical insulation, flotation chambers, or protection against heat, cold, sound—flexible foams for vibration or impact absorption . . . whatever type of polyurethane you're looking for, Barrett can supply the right PLASKON Polyester.

If you would like to know more about PLASKON Polyester Resins—and how they can serve you—write to BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y. In Canada: The Barrett Company, Ltd., Keating and Saulter Streets, Toronto 8, Ontario.

POLYURETHANE FOAMS

PLASKON Polyesters for rigid foams can be foamed easily in place (as in this boat hull or in wall partitions) or in inexpensive molds on a batch or continuous basis.



PREMIX MOLDING

Cost-saving premix operation permits the rapid molding of reinforced parts with varying thicknesses, intricate contours or molded-in inserts. Used for automobile heater and radio speaker housings.

PLASKON® POLYESTERS . . . leader in the field

Polyester Resins ★ Molding Compounds
Urea ★ Melamine ★ Alkyds ★ Nylon ★
Industrial Resins ★ ★ Coating Resins

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For exact dimensional reproduction in every part. Molded under pressure and heat in metal molds to assure consistent mechanical performance, physical properties and rapid production. Examples: chairs, luggage, marlane housings.

Barrett PLASKON®

The Challenge to Plastics

A Guest Editorial by Hiram McCann

Born 1908 in Carlton Place, Ontario, Canada. Became a newspaper reporter at 16 years of age. Graduated from MacMaster University in Political Economics in 1929. Joined MacLean Publishing Company as News Editor of business papers and from that day to this has been connected in either a managerial or editorial capacity with twenty four different industrial or trade publications, giving him a broad range of interest and contacts.

During World War II while Chief of the Industrial Magazines Division of Consolidated Press, Ltd. in Toronto he was loaned to the Canadian Government to become Executive Secretary to the Food Conservation Board of the Dominion of Canada and also acted as Public Relations advisor to the Dominion Department of War Finance.

Joined Modern Plastics Magazine as Eastern editor in 1945 and became editor in 1948.

The elements in the economy that most affect this industry—since so much of plastics production is in the form of components used by end-product industries—are population growth, standard and style of living, materials costs, taxes, and distribution.

For the next eight years, up to 1965, our population growth has been charted. We will have then 190 million people compared to about 170 million today. But—and **this** is the **key** to our future production and sales policies in plastics—our work force will **NOT** increase in proportion to our population increase. We will have many more older people and many more younger people and if we don't achieve automation on a big scale, those of us in the working age group are going to have to work a lot harder. Our gross national product today is around 440 billion dollars and a consensus of leading economists indicates that we will have to produce somewhere between 500 and 550 billion dollars in economic values in 1965. With our population increasing at a rate of almost three million a year, it is hard to imagine a labor shortage seven or eight years from now, particularly with the productivity of labor continually on the increase. But the simple fact is that a mere extension of our present manufacturing, distribution, and service facilities on the basis of present types of capital equipment, if we are to produce a gross national product of even 500 billion by 1965, we would have a **need** for 92 million workers, and our total available labor force would only be around 74 million.

This is going to be especially true of the plastics industry, and therein lies your challenge and your opportunity.

Our present end-user industries—the automobile manufacturers, the home appliance and refrigerator makers, the electronics industries, the furniture field, and many others are looking forward to this brave new world of rapid family formation, high standard of living, two cars in every garage, but they are also looking forward to some means of dealing with a dilemma of increasing importance on the horns of which they, as we, are hung. This is the dilemma of higher sales and lower profits.

Let's take a small case in point. Here is what has happened to basic costs of raw materials in a household refrigerator in ten years:

Hot Rolled Steel	Up 87%
Cold Rolled Steel	Up 80%
Enameling Iron	Up 78%
Copper	Up 50%
Aluminum Sheet	Up 31%
All Plastics	DOWN 11.5%

You can see that plastics is the **one bright hope** in the cost picture of domestic refrigerator manufacture.

Now, it may be, as has been suggested to me by a big custom molder and fabricator, that the plastics industry, particularly at custom level, has been pricing itself too low, because the custom molder competes today not only with other custom molders but with captive plants or with the **threat** of captive plants. And it may also be, and I suspect in many instances the facts would prove, that our custom enterprise in general has not kept up with the times in terms of automation, design for lower cost, inspection and diminution of rejects, and in selling.

This same aspect of increasing costs in a period of high taxation and higher costs of living is a bugaboo of the automotive industry, the building industry, and every other industry you care to think of. This bugaboo of increasing costs in an era of fierce competition is the greatest single challenge to the plastics industry in the next few years.

The challenge to plastics and to the plastics industry is to help its end-user industries **stem the rising tide of costs.**

If the present plastics processing industries—molders, fabricators, extruders, and so forth—want to share in the use of plastics in the construction field, they'll have to toss some big blue chips into the game to buy research, development, and capital equipment.

The trend toward **captivity** is quite obvious. Take the statement made recently by the purchasing head of a big home appliance company. He stated that he has set up a "make or buy" committee to keep track of costs on every component, comparing costs of components purchased with foreseeable costs to him if the component were to be made in a captive plant, and where custom bought components are out of balance in cost over any period of

(please turn to page 73)

Hydraulic Fluids for Molding Presses

K. G. Henrikson and J. R. Hicks

Socony Mobil Oil Co.
New York, New York

Plastics molding presses, whether for injection or compression molding, employ hydraulic actuation because this method readily provides the desired high speed, ease of control and the great force that is needed for mold closing. Many presses are automatic to the point that the operator needs only to handle finished parts at the end of each cycle. The presses, cycling away, appear to be tireless and trouble-free. In many plants trouble-free operation is in fact obtained, and where this is so, two things will be found: the hydraulic fluid is correct for the job, and it and the hydraulic system are maintained in good condition.

Where poor hydraulic oils are used, or where maintenance is neglected, machines become sluggish, parts wear out, and leakage is a continual problem. Shutdowns for repair and replacement of parts are frequent. Repairs are costly—both for labor and parts—but these costs are often small compared to the cost of lost production when a press must be shut down.

When a high-quality, properly selected hydraulic fluid is used and kept in good condition through good preventive-maintenance practices, shutdowns—either scheduled or emergency—can be held to a minimum. The quantity and quality of production can be maintained and manufacturing costs are reduced.

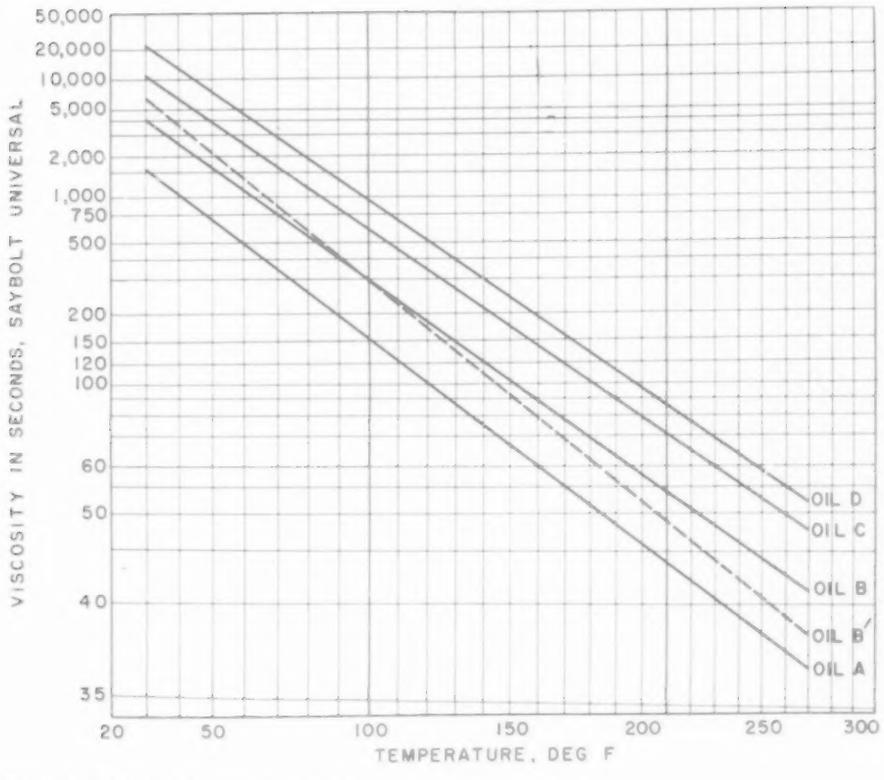


Fig. 1. Variation of Viscosity with Temperature. Oils A,B,C, and D are widely used in hydraulic systems. Their viscosities are, respectively, about 150, 300, 600, and 900 SSU (Seconds, Saybolt University) at 100 F. The variation of viscosity with temperature is shown. Considering any one of the oils, as compared to its viscosity at 100 F, its viscosity at lower starting temperatures is much higher, and at higher operating temperatures, much lower. In the USA, the following approximate limits have been set by builders of hydraulic equipment: 4000 SSU maximum at the starting temperature of the oil in the reservoir, and 60 to 70 SSU minimum at operating temperature. Above about 1000 SSU, cavitation may occur in pumps; below 60 to 70 SSU, internal leakage may be excessive. Oils A, B, C, and D are high-viscosity-index oils —95-VI minimum. To show the effect of VI, the variation of viscosity with temperature for Oil B'—a 50-VI oil—has been shown. Although its viscosity at 100 F is the same as that of Oil B, its viscosity at lower starting temperatures is higher than that of Oil B, and its viscosity at higher operating temperatures is lower than that of Oil B.

Hydraulic-Fluids Qualities Required by Press Systems

Press circuits vary, of course, depending on the molding process and the press builder. Elements always included, however, are (1) a reservoir, (2) pumps, (3) piping, (4) control valves, and (5) hydraulic cylinders. A sixth element, the hydraulic fluid, is the "life blood" of the system.

Except in a few special cases, the hydraulic fluid used in plastics-molding presses is a petroleum lubricating oil.* To be suitable for the purpose the oil should have certain qualities required by system elements, especially the pumps. These qualities include proper **viscosity** and **viscosity index**, and adequate **film strength**. Operating conditions affect oil service life and require certain other oil qualities as follows: high **oxidation stability**, and good **anti-rust property**, **water-separating ability**, and **resistance to foaming**.

Viscosity

Movement between surfaces separated by a thick film of oil is not frictionless because of the internal friction, or **viscosity**, of the oil itself. Viscosity also accounts for oil's resistance to flow.

Low-viscosity **(light-bodied)** oils flow freely; high-viscosity **(heavy-bodied)** oils flow sluggishly.

Viscosity is one of oil's most important properties. It plays a part in the formation of lubricating films between moving parts such as pump vanes, pistons, or valve spools and their mating parts. It is a factor in sealing close-clearance parts against leakage in pumps, cylinders, and valves. It plays a part in pressure loss due to flow in tubing, hoses, and the like, and in the response of press movements to controls. Unfortunately, in some cases, the requirements for viscosity are conflicting, and compromises must be made. For example: high viscosity provides stronger lubricating films. Low viscosity results in less internal friction loss and less heating. High viscosity reduces internal leakage. Low viscosity results in less pressure loss due to flow in tubing. Low viscosity results in fast control action and snappy machine response. In general, hydraulic machine builders specify the viscosity that is most suitable for the pumps, and other elements of the system are designed accordingly. The builder's recommendation should be followed.

Oil viscosity varies substantially with temperature. It decreases as temperature increases and increases as temperature decreases (Figure 1). An oil that changes relatively little in viscosity with temperature is said to have a **high** viscosity index, or high **V.I.** Viscosity index is not a critical property in this application since the hydraulic fluid is not subjected to a wide temperature range. Moderate-to high-V.I. oils are satisfactory.

Film Strength

Wear of hydraulic pump, cylinder, and control-valve parts causes increased leakage, loss of pressure, and less-accurate control. In time, a machine must be shut down, and this can be costly. For example, to remove, repair, and re-install a vane pump costs at least $60 for labor and parts (**plus** the cost of lost production). An important oil quality is its ability to minimize wear under the thin-film, or boundary, lubrication condition that exists between these closely fitted sliding parts. A suitable oil maintains on these surfaces strong films that resist being squeezed out or pushed aside. Metal-to-metal contact, with attendant wear and high-friction, is minimized. Modern hydraulic oils contain additive materials that provide excellent protection against wear, or film strength.

Oxidation Stability

Oil is circulated over and over, during long periods, in hydraulic systems. It is heated by the churning and shearing action in pumps, valves, and tubing. Also the energy released as oil is bypassed from high to low pressure in a relief valve is converted to heat, which raises the temperature of oil in the reservoir. Sometimes the oil temperature is further increased by heat flowing from machine parts, such as the hot dies of a press for a thermosetting plastic.

The oil is in contact with warm air in the reservoir. Some air is always dissolved by the oil and still more air may be entrained in bubble form. Because of this contact with air, oxygen is intimately mixed with the oil. Under these conditions, some of the oil may combine with oxygen in a series of steps, or chain of reactions. The process is called oxidation, and a variety of products are formed, including acidic, viscous, and deposit-forming materials.

The tendency to oxidize is greatly increased at high operating temperatures and by excessive agitation or splashing of oil. Under normal conditions the operating temperature of oil in plastics-molding press reservoirs ranges from about 100 to 130 F. However, temperatures may be much higher. This can occur, for example, if a cycle must be set up so that there is a prolonged dwell during which high-pressure oil passes through the relief valve. High temperature can also occur if the oil cooler is not working properly.

Copper, iron, rust and certain other metallic materials commonly present in hydraulic systems act as oil-oxidation promoters, or catalysts. This action is most severe when (1) these materials in finely divided form are mixed intimately with the oil, (2) when moisture is present, and (3) at higher temperatures.

Slight oxidation may not have noticeable results, but if the oil has poor resistance to this chemical change, oxidation may become excessive. If this occurs, substantial amounts of acidic materials and insoluble products will form and the oil will gradually increase in viscosity.

Insoluble products may be deposited as gum or sludge in oil passages, pump parts, and valve ports where their accumulation will restrict oil flow. They may slow up the movement of pump vanes or spool-type valves (Figure 2) and may cause seated valves to leak. Any of these effects could cause sluggish press action and loss of accurate timing.

Another very harmful effect of insoluble oxidation products is that they accumulate on suction screens and prevent free flow of oil into pumps. With an unsuitable oil, the deposit may build up to the point where severe pump starvation occurs. This condition results in erratic flow, wear, and noise.

Some oxidation products are soluble at higher temperatures, but become insoluble at lower temperatures. They precipitate to form deposits on oil-cooling coils or other cooling surfaces where temperatures are low. Under severe conditions, the layer of deposit on these surfaces may seriously reduce the effectiveness of cooling. As a result, oil temperatures will be higher and the rate of oxidation will tend to increase.

Low-quality oils have poor resistance to oxidation

*This article does not discuss the soluble-oil emulsions used in the central hydraulic systems of some of the large compression molding shops, nor fire-resistant hydraulic fluids, which are not used to any extent in plastics-molding presses.

and under severe conditions form sludge in a relatively short time. With such oils in service, troubles of the kinds just described often occur. For long service in hydraulic systems, the hydraulic fluid must have high oxidation resistance to protect against the formation of sludge (Figure 3) and, in general, to maintain all initial characteristics. In high quality hydraulic fluids, high oxidation stability is achieved through the use of a carefully developed base oil-additive combination. The additives included should have the ability both to interfere with the chain of oxidation reactions and to reduce the catalytic action of metals.

Anti-Rust Property

Water and oxygen can cause rusting of ferrous surfaces in hydraulic systems. As air is always present, oxygen is available, and some water is often present. The possibility of rusting is greatest during shutdown when surfaces that are normally covered with oil may then be unprotected.

Rusting results in surface destruction, and rust may be carried into a system where it will contribute to the formation of sludge-like deposits that will interfere with the operation of pumps, control valves, or cylinders. Larger rust particles can cause abrasion of pump, valve, and other parts. Rusting of piston rods or rams causes rapid packing wear and increased leakage of oil.

In guarding against rusting, it is important to keep hydraulic systems as free of water as possible. This cannot always be accomplished completely, and it is therefore desirable to use an oil that has anti-rust properties. High-quality hydraulic fluids contain an additive material, called a rust inhibitor, which has an affinity for metal surfaces. It "plates out" on the surfaces, forming a film that resists displacement by water and, therefore, protects the surfaces from contact with water. The rust inhibitor must be carefully selected to provide adequate protection without materially reducing other desirable properties, especially water-separating ability.

In addition, suitable screens and filters should be used to prevent the circulation of rust particles and other solid contaminants.

Water-Separating Ability

Water contamination is sometimes a problem in hydraulic systems of molding presses. It may be present as a result of water leaks in oil coolers, but more commonly it accumulates because of the condensation of atmospheric moisture. Most condensation occurs above oil level in reservoirs as machines cool during idle periods. The reservoirs of some injection-molding machines are located under the die area, and when cooling-water connections are broken to change molds, water will get into the reservoirs if all openings are not well sealed. A clean oil of suitable type will have little tendency to mix with water, and in a still reservoir, the water will tend to settle at the low point. During operation, the water may be picked up by oil currents, broken up into droplets, and mixed with oil to form an emulsion. The water and oil in such an emulsion should separate quickly in the reservoir, but when solid contaminants (dirt, dust, and the like) or oil-oxidation products are present, emulsions tend to persist and to join with any other deposit-forming material present to form sludge.

Persistent emulsions may develop into slimy, sticky substances that foul pumps, controls and cylinders. They deposit in oil lines and passages and, eventually, make it impossible to operate the machines. To prevent these

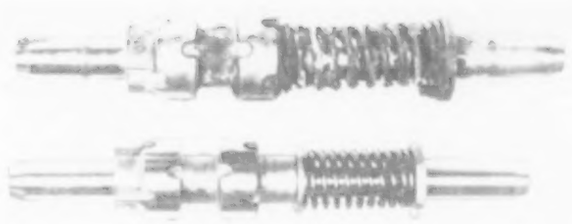


Fig. 2. Clean and Dirty Spool Valves. Deposits prevent free movment of closely fitted parts such as spool-type control valves.

results, it is essential that a hydraulic oil have the ability to separate quickly and completely from water. Properly refined oils have this ability when new, but only those oils having exceptionally high oxidation resistance retain good water-separating ability over long service periods. In addition to using such an oil, every effort should be made to keep systems free of contaminants.

Resistance to Foaming

Oil in a hydraulic-system reservoir commonly dissolves a certain amount of air. Also, air bubbles may be mixed into the oil by oil streams returning from the system or

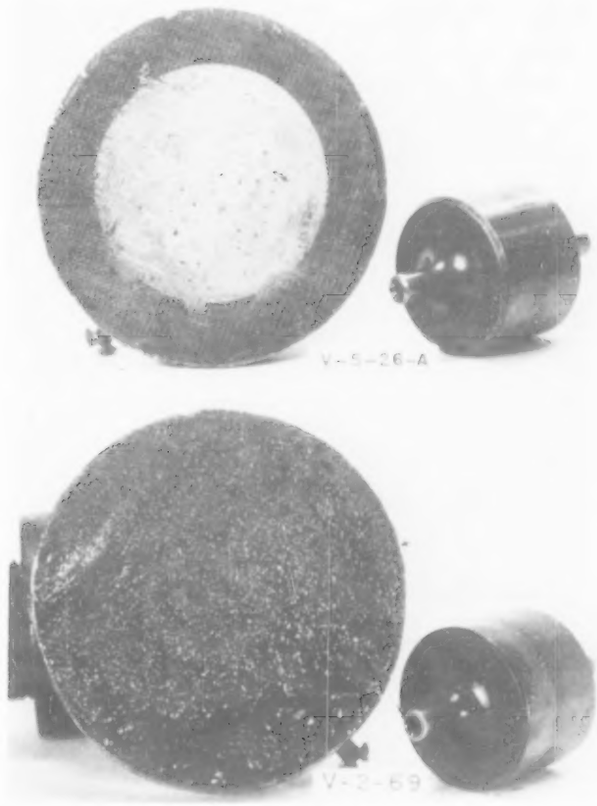


Figure 3. Deposits on Pump-Suction Screens. Oils that are described as premium quality, and which may rate well in certain oxidation-stability tests, are not necessarily satisfactory in their ability to resist deposit formation. These photographs of pump-suction screens were taken at the end of identical runs with different oils in a pump test operated under simulated severe-service conditions (1000 psi and 175F oil temperature). The screen at the top is clean, while that at the bottom has accumulated a heavy layer of sludge. Note also the gummy deposit on the relief-valve piston at the bottom right. An oil should be used that is known to resist deposit formation in service.

discharging from relief valves. The air bubbles may be drawn into the pump suction along with oil or through leaks in the suction line. If the oil level falls too low, air bubbles may be drawn in directly at the pump-suction screen.

At the higher pressure on the discharge side of the pump, the oil has increased capacity for dissolving air and is usually able to absorb amounts of entrained air bubbles normally present. However, if an excessive amount of air is present so that bubbles persist at operating pressure, pumping will be noisy and irregular, and the action of controls will be erratic. In such a case, the cause of excess air should be corrected.

As oil pressure is reduced in passing through work cylinders and relief valves, its ability to hold air in solution is reduced. Excess air, if any, comes out in bubble form and is swept along to the reservoir. Here, if the oil has good resistance to foaming, and the reservoir is properly designed, the air will free itself readily at the oil surface.

New premium-quality oils have good resistance to foaming but oxidation and contamination tend to destroy this property. Therefore, in addition to guarding against contamination, it is again necessary to use an oil of high oxidation resistance in order to preserve initial oil qualities.

How to Maintain Good Hydraulic-Fluid Qualities

Maintaining good hydraulic-fluid qualities consists essentially of minimizing oxidation and contamination. What molding-press operators can do comes under the following headings: Keep reservoir temperatures low, keep hydraulic systems clean, and keep hydraulic oils clean.

Keeping Temperatures Low

The steady temperature reached by oil in the reservoir is determined jointly by the amount of heat developed and the heat-dissipating ability of the system. With moderate room temperatures, reservoirs can usually be maintained in the range often recommended by press builders —120° to 130°F.

When reservoir temperatures in a particular system run above normal, the following points should be checked: (1) **Surroundings.** Much heat is dissipated by radiation and convection from the side walls of the reservoir. See that cooling air has access to all side-wall areas. (2) **Oil cooler.** Check cooling-water temperatures in and out and water flow. Also, inspect for oil-side and water-side deposits, and clean if necessary. (3) **Circuit.** Sometimes, poor hydraulic circuit design or wrong-size equipment causes high oil temperatures. For example, if a pump is oversize, much of its output may be discharged uselessly through a relief valve. Or, a relief valve may be set to maintain a higher system pressure than necessary. Along this same line, a cycle may have been changed so that there are long periods of dwell or holding action during which most of the pump output is discharged at high pressure through the relief valve. In all these cases, energy is needlessly converted into heat. (4) **Oil viscosity.** As discussed previously, an oil of either too high or too low a viscosity can cause high oil temperatures.

When these points have been checked and appear to be in order, and high temperatures still persist, the press builder should be asked to investigate. Several design factors can contribute—for example, volume of oil, shape of reservoir, arrangement of baffles, and location of suction and return connections.

Keeping Hydraulic Systems Clean

Dirt, water and oxidized oil contribute to the formation of emulsions, sludges, deposits, rust and to abrasive wear. Such contaminants should be systematically removed from hydraulic systems. However, much of this effort can be saved if adequate steps are taken to prevent contaminants from entering the systems in the first place.

Even new systems may be contaminated with such materials as pipe scale, rust particles, pipe-thread compound, core sand and paint flakes. The piping of large systems installed on the job may contain weld spatter, chips from tapped holes and rust which require removal. Filters and screens should be watched carefully during the first few hours of operation, and it is good practice to examine the oil after a few days of operation.

From the time hydraulic systems are put into service, contaminants (dirt, plastics dust, and so on) may enter at several points unless definite preventive steps are taken.

Preventing Contamination. Preventing contamination involves both design features and good "housekeeping" practices. In finding and eliminating points of entry, the following recommendations may be helpful: (1) The **reservoir cover,** if of removable type, should be gasketed.

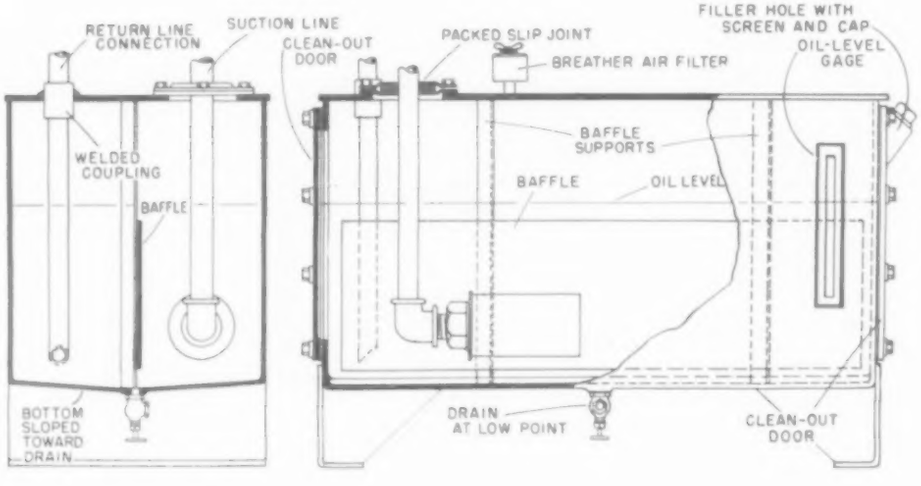


Fig. 4. Hydraulic-Fluid Reservoir. Features Which Help to Keep Systems Clean are shown.

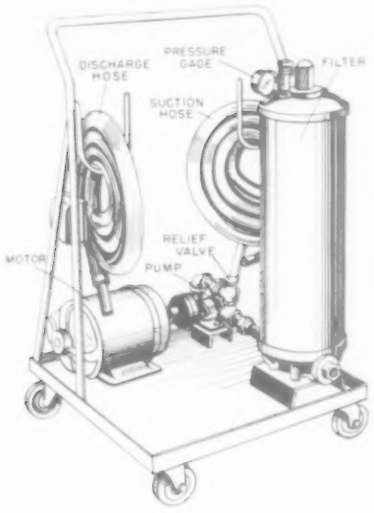


Fig. 5. One Type of Portable Filter.

and should be tightly bolted on. (2) **Clearance holes** in the reservoir cover for suction and drain lines should be well sealed (Figure 4). (3) The oil **filler hole** should be fitted with a fine-mesh screen and a dust-tight cover. (4) The **breather hole** should be provided with an air filter, which should be cleaned regularly. (5) The **suction screen** should be inspected regularly to see that it is not clogged. (6) **Piston rod packing** in a dirty atmosphere should be protected by means of a bellows-type boot or an effective wiper ring. Moving or stationary sheet-metal guards can sometimes be used effectively to shield piston rods from falling dirt, plastics dust and water. Regular inspection of hydraulic systems should be made to detect contamination and observe the oil condition.

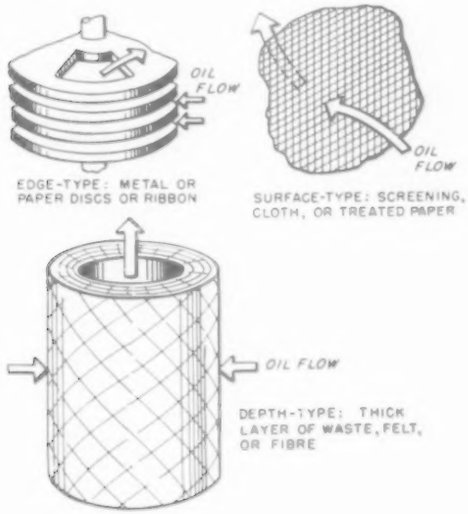
The required frequency of inspection depends on the type and condition of a system, the type and quality of oil in service, and on operating conditions. The oil supplier should be asked to set up this program and instruct lubrication maintenance men how and when to inspect systems and examine oil samples.

Removing Contamination. Much of the contamination that gets into a hydraulic system accumulates in the oil reservoir. However, deposits may also form in pumps, valves, fittings, and oil coolers.

New oil has greater solvent power than used oil and tends to loosen deposits and move them from harmless locations into mechanisms where they may interfere with the movement of parts. Systems should therefore be cleaned regularly as the need is indicated by inspection. Cleaning should especially be considered prior to the installation of a new oil charge.

Two cleaning methods are suggested: (1) If inspection shows that the oil is in poor condition but the machine is operating satisfactorily and there is no indication of deposits throughout the system, the machine should be shut down and drained immediately. The reservoir should then be cleaned, and the system refilled with new oil. (2) If the machine does not operate properly and inspection shows that there are deposits in valves and other parts of the system, a small percentage of a special petroleum solvent cleaner should be circulated with the oil charge for a long enough period to loosen and remove the deposits. Then the oil should be drained while it is hot, the reservoir should be cleaned manually, and the system refilled with new oil.

Fig. 6 Size-Filter Principles. Oil is forced by pressure through minute openings, fine pores, or a depth of fibrous material.


OIL FLOW
EDGE-TYPE: METAL OR PAPER DISCS OR RIBBON
OIL FLOW
SURFACE-TYPE: SCREENING, CLOTH, OR TREATED PAPER
OIL FLOW
DEPTH-TYPE: THICK LAYER OF WASTE, FELT, OR FIBRE

SIZE-FILTER PRINCIPLES

Keeping Oil Clean

In spite of efforts to keep contaminants out of hydraulic systems, hydraulic fluids are commonly contaminated to some degree, and purification means should usually be provided in connection with the over-all program for keeping both fluids and systems clean.

Press circuits commonly include a bypass filter on the discharge side of the pump. In addition, in many plants, portable filters are used. These have their own pumps, hoses, and other parts (Figure 5), and are connected to reservoirs periodically—as often as is necessary. A portable filter should be of such a capacity that the oil in a system can be cleaned up during a period of about 24 hours.

Where oil cannot be kept sufficiently clean by "on-machine" filters, it can be removed and purified in a suitable batch system.

Filters should usually be of the size type (Figure 6). These have elements made of such materials as treated paper, waste, felt and fabric and are capable of holding back fine dirt and other solid contaminants without removing additive materials used in high-quality hydraulic fluids.

Filters accumulate solids and will sooner or later become clogged. Therefore, schedules should be established for renewing filter packs and cleaning filter housings.

Keeping oil clean involves much more than proper filtration. The program should start in the oil house and carry right through every stage of handling and dispensing hydraulic fluids and lubricants. The lubricant supplier should be able to assist in setting up a program that will be especially suited to conditions in a particular plant.

Leakage Control

Leakage of hydraulic fluid is perhaps the most persistent trouble that occurs in plastics molding plants. The continual shock and vibration of press action causes joints to loosen and may cause rigid pipes or tubing to break as a result of metal fatigue. On the other hand, leakage may result from the use of unsuitable types of joints or gaskets, or lack of care in preparing and making up connections.

The latter is often true where operations such as the

threading of pipe or the cutting and burring of tubing are involved. Sometimes hoses are installed so that they twist or rub against rough surfaces. Either can lead to early failure.

Leakage is costly. It can easily amount to $50 a year for even a small machine. This multiplied by the number of machines in a shop can be a substantial loss. In addition, make-up must be added and the labor necessary to maintain the level in the oil reservoirs of a large number of leaking presses can be a large item. Also the leaking oil often gets on the floor around the machines and creates a safety or fire hazard. To reduce this hazard, extra cleaning labor is required to mop up the oil from the floor. In some shops, a clay-type material is spread on floors to absorb oil leakage. The cost of such a material and its application may be substantial. If leakage becomes so excessive that a press must be taken out of production for repair, the cost of the lost production from the machine may be much more than other costs mentioned.

Leakage can be controlled by correct maintenance procedures. The press builder's service organization can be most helpful, but again the oil supplier should be called on for assistance. He should have a store of knowledge and experience that can be applied to solving leakage problems.

Preventive Maintenance

Hydraulic-fluid qualities and the reasons they are needed in plastics-molding-press service have been discussed. Several qualities were seen to be essential, and it was shown to be highly desirable for these qualities to be maintained in service so that presses need not be shutdown for maintenance for long periods.

As pointed out, long service life demands a hydraulic fluid that has high oxidation stability. This quality cannot be obtained in a cheap, low-quality oil. Such oils should be drained frequently, and it is often necessary, prior to draining, to circulate a solvent throughout a system to remove gummy deposits.

Where a system leaks so badly that the benefits possible from using a high-quality oil cannot be fully realized, the use of an intermediate-quality oil can sometimes be justified as a stop-gap measure. Suitable drain frequencies should be established.

The most economical operation of a molding press will be obtained with a premium-quality additive-type hydraulic fluid. These oils can be left in service for very long periods in tight systems where good preventive maintenance is practiced.

Many preventive-maintenance measures have been suggested in the fore-going section "How to Maintain Good Hydraulic - Fluid Qualities." These should be included in a program that should be developed for each particular plant. The heart of such a preventive-maintenance program is **inspection**. A complete inspection of every hydraulic system should be made by a trained lubrication maintenance man at regular intervals (which range from one to six months depending on severity of service). He should look at temperatures, pressures, cycle time, leakage, and means for preventing contamination. He should examine a sample of oil visually and also examine accessible parts of the reservoirs. An experienced man can then decide whether the oil should be left in service or whether it should be drained and to what extent cleaning is necessary. Where a large quantity of oil is involved, a laboratory analysis of an oil sample may be obtained before a decision is made.

Preventive - maintenance work should be carefully scheduled, and records should be kept of oil condition, maintenance costs, and savings resulting from good maintenance practices (Figure 7). Major savings can be made by continuing high-quality oil in service if it is in good condition. This saves not only direct oil costs, but also drum-handling costs, and the cost of labor for draining, cleaning and refilling. Draining,

(please turn to page 73)

Figure 7. Lubrication Record. Front and back of card that can be used for recording hydraulic system maintenance.

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.

MACHINE — Mobil — PROPOSED CO-1948 (7-56)

MODEL NO. SHOP NO. **LUBRICATION RECORD** DEPT.

PARTS TO BE LUBRICATED	METHOD OF APPLICATION ①	LUBRICANT	WHEN TO SERVICE	WHEN TO CHANGE

FRONT

MACHINE MODEL NO. SHOP NO. ① ALSO INDICATE CAPACITY WHERE METHOD OF APPLICATION IS BY RESERVOIR

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.

QUANTITIES ADDED TO RESERVOIRS

BACK

REPAIRS

DATE	DESCRIPTION OF REPAIRS	LUBR. INVOLVED?

A Reinforced Plastics Cash Register

Mario Petretti

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Zeeland, Michigan

THE POSSIBILITY of using reinforced fiberglass plastics for the production of a cash register housing was examined. It was decided that due to lack of correlative engineering data on fiberglass reinforced polyester plastics, that we proceed cautiously and produce a prototype in order to determine the feasibility of the application. A wooden model was supplied by Victor Adding Machine Co. We proceeded in the fabrication of a prototype, which was unique within itself in that it was fabricated from a preform rather than a customary cloth mat combination. The prototype mold consisted of a matched plastic male and female mold produced from the wooden male model as supplied. The steps in the fabrication of the plastic tooling were as follows:

1. Customary treatment of the wooden male model with lacquer sealants and waxes.

2. The application of 3/32" pattern makers sheet wax to compensate for the wall thickness. The sheet wax was shellacked and waxed and a separator film of P.V.A. applied. A female mold was produced therefrom by the application of multi-layers of glass cloth and room cure type polyester resin. On the completion of the female mold, the procedure was reversed wherein a layer of 3/32" pattern makers sheet wax was applied to the inner side of the female mold and a fiberglass male mold produced by the hand lay-up technique. The finished lay-ups were then machined for parting lines and fabricated into a Marco-type mold for the fabrication of the prototypes necessary.

This paper is a revised version of a talk presented before the SPI Reinforced Plastics Meeting in Chicago.

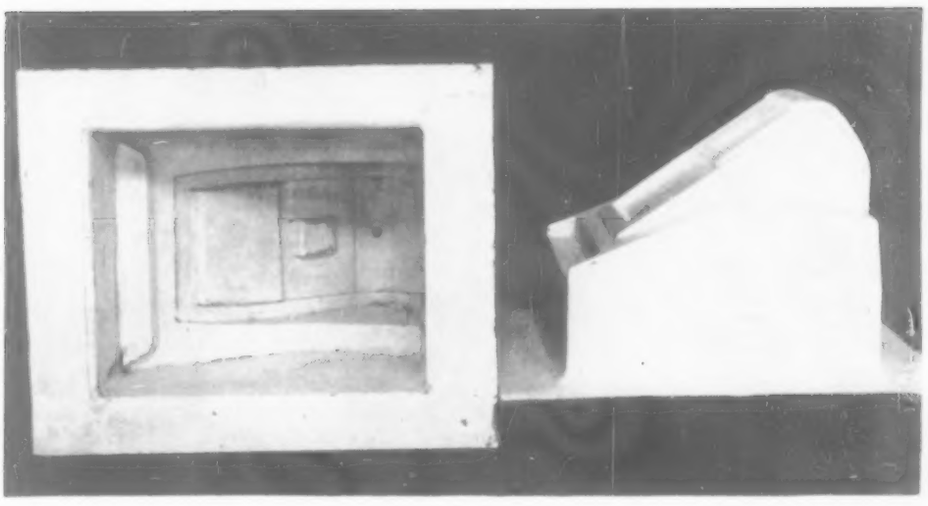

Figure 1. Marco method matched plastic molds for prototype fabrication.

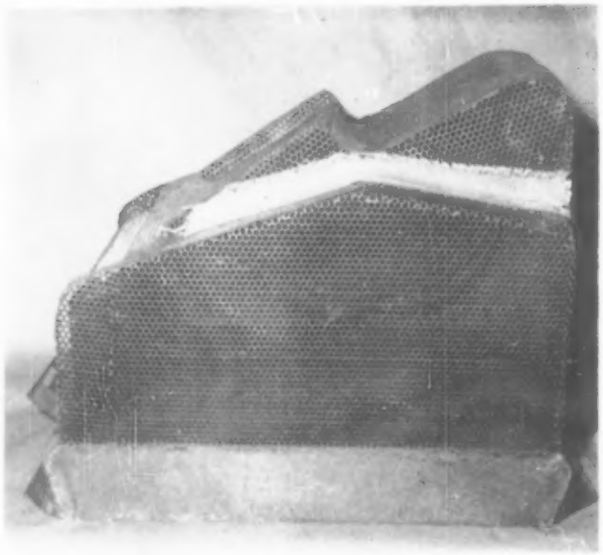

Figure 2. A side view of the production preform screens.

Figure 1 shows the Marco method matched plastic molds with blow-off and vacuum ports visible.

These Marco molds combined both case and cover. The cover section was cut off from the major section, machined and refitted to form the hinged cover complete with tape and key slot openings, hinge and lock bosses. These hinge and lock bosses were machined from pre-mix and cemented to the cover with Armstrong epoxy cement.

Preforms for Prototypes

We chose to utilize preforms rather than the customary glass cloth and mat combinations in the fabrication of the prototypes. This was predicated on the feeling that the preforms would be in closer relationship in regard to the physical properties of the production parts by the matched metal molding process which was under consideration. Our feeling was that these prototypes would have approximately 60% of the strength of those produced later by the matched metal production tooling. The samples by necessity of the Marco process contained no fillers but incorporated a pigmented gel coat on both sides.

The major problems that presented themselves were:

1. The problem of preforming the part on a production basis.
2. The apparent molding problems due to change of contour and lack of draft.
3. The problem of the tooling itself.

The problems being equal, we decided that if we could lick the problem of preforming, the other stages could be taken in stride as we progressed.

The Fabrication of Preform Screens

The fabrication of the preform screens was accomplished by the utilization of the male model. Figure 2 shows a side view of the production preform screens, which differ very little from the original prototype screens.

These screens are fabricated from expanded metal having 3/16" diameter holes on 1/4" centers on the major portion of screens, and 1/8" diameter holes on 3/16" centers on the minor portion in the cut-out sections. It was necessary to carry the ¼" diameter holes into the cut-out section about 1-1/2" to insure uniform glass distribution on the vertical walls of this keyboard opening. The baffles shown on the screen are fabricated from style 100 glass cloth and work very satisfactory.

On the evaluation of the prototypes, all parties concerned were satisfied and further changes were incorporated. It was felt at that time that the majority of the problems seemed to be surmountable (See Figure 3 for a section of original prototype) and, thereupon, the designers went further in asking that two wings be added on the cash drawer face for appearance purposes (See Figure 4, wooden model with changes added).

The new design presented a new set of problems and again we proceeded through the same prototype stages.

Upon the receipt of the second series of prototypes, drawings were frozen after many discussions, and estimates were secured from tool sources for production tooling. It should be pointed out at this time that the

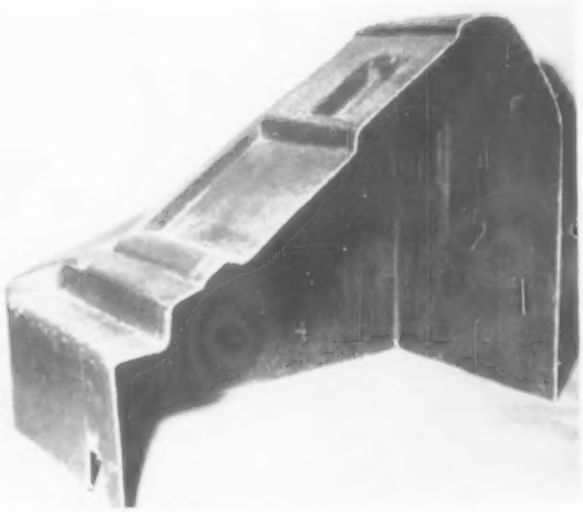

Figure 3. Section of original prototype housing.

Figure 4. Wooden model with changes incorporated.

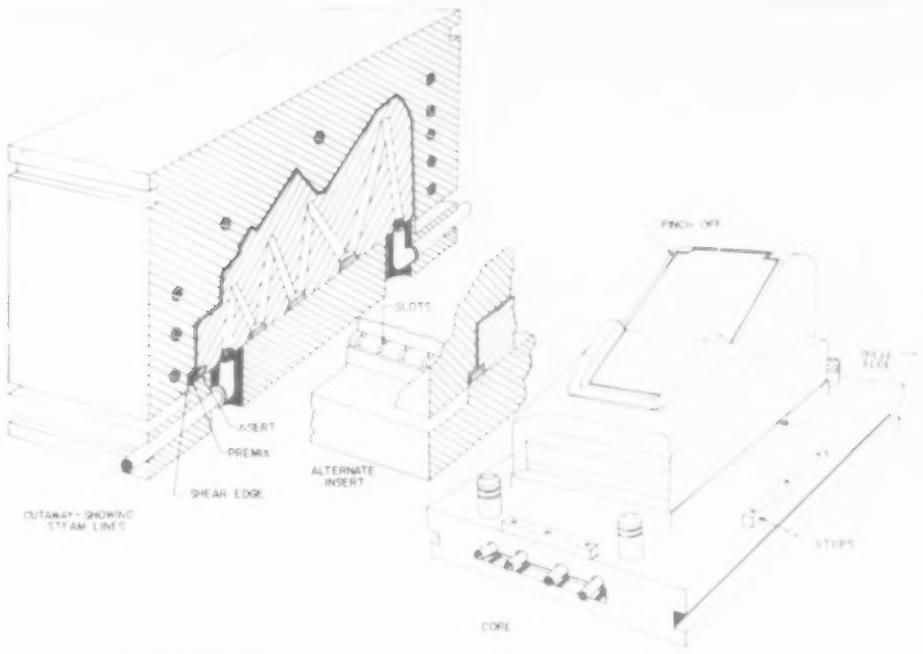

Figure 5. Alternate design would use insert for stiffening.

tooling in itself constituted a serious major problem. Due to the consideration of volume production and the design, at no time were castings of any type or material considered, but rather the tooling was to be cut from either prehardened CSM#2 or 1045 steel.

A few of the problems were: (1) On the cash register bottom there were basically three different tapers (draft angles) on the parts ranging from 0°45' on the front face, and on the sides to a height of approximately five inches to the base line the remaining draft being 4°30'. The overall maximum tolerance on the case was to be held minus .000 plus .015. (2) Radius varied from sharp corners to 1/16 to ⅛ maximum. (3) On the wall thickness, tolerance was held to .093 minus .000 to plus .007. This, in our mind, made the problem more complex and upon discussing it with the tool makers, restricted the number of tool shops who could produce it. It was decided to Keller both the core and the cavity. We also asked that a semi-sheer be incorporated for the keyboard and mechanism openings. These are on the upper face of the case. These semi-shears or pinch-offs were necessary to insure the uniformity of the glass content and strength of the vertical wall.

An alternate design or engineering hedge was incorporated into the tool design on the front face of the cash drawer overhang between the front face wings. This was the use of premix polyester molding material in the form of a solid half-by-half-inch bar molded simultaneously with the preform within the same mold in the same molding cycle. Our alternate design in the event that we were not successful with this premix-preform combination is shown as alternate insert in Figure 5. This alternate would have been the insertion of pieces of fiberglass mat on 2" centers for the necessary stiffening. After much deliberation and evaluation, we chose to proceed with this engineering hedge of the solid bar of premix compound.

The cover of the cash register presented many problems; primarily, the ability to clean shear the tape opening (See Figure 6 wooden model for the register top.) There are two vertical angular bosses 1/2" x 1/2", one on each side of the cover, which prevented off-setting the core and cavity of the mold sufficient to shear out this tape opening on a level plane.

We also incorporated the use of premix in conjunction with preforms and surfacing veil to form hinge bosses for the self-tapping screws as well as these premix bosses for the cover locks. After the decision as to the choice of toolmaker was reached, it required close liason between our engineering staff and coordination with the industrial designer and the customer. This close coordination was necessary due to the importance of working to the models rather than drawings alone. We would like to point out on such a project that we feel any other shortcuts would have led to disaster.

Mahogany Keller models were provided, and these models were checked by the designers, by the customer and ourselves prior to their delivery.

It was decided to fabricate the tooling from forgings of SAE-1045 steel and flame harden the shear edges and pinch-offs.

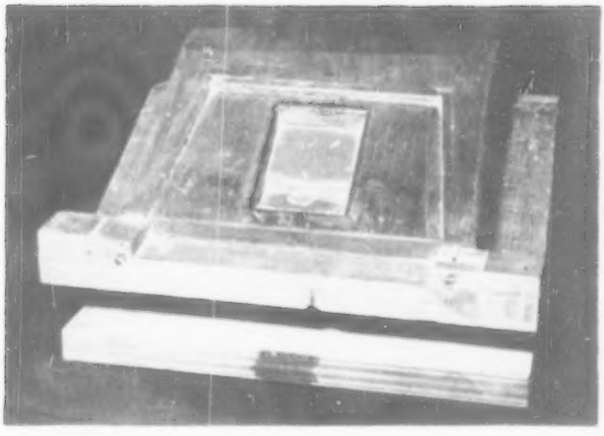

Figure 6. Wooden model for top of cash register.

Figure 7. Routing the cash drawer.

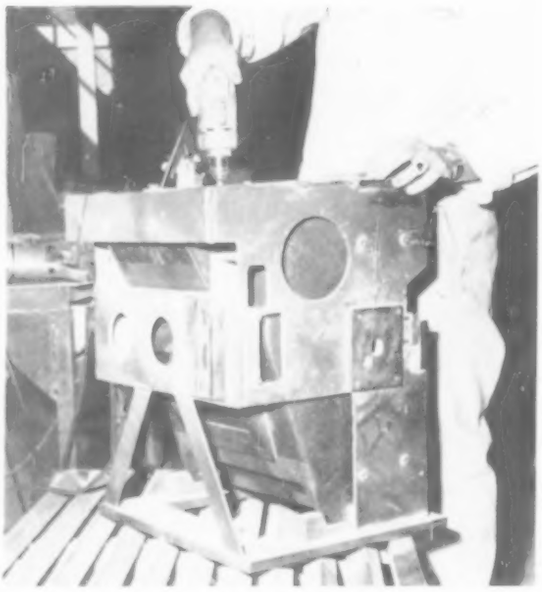

Figure 8. Drilling and routing fixture.

Figure 9. Start of pour pattern.

It became very evident at the early stages of both the tool design and tool construction of the importance of uniform heating of a die of this configuration and size. We therefore, went into considerable detail as shown by Figure 5, which, I might add, proved very satisfactory.

Supplemental tooling consisted of drilling and routing fixtures for performing the following operations: (1) cash drawer opening; (2) keyboard and mechanism openings. The side slots and attachment holes presented quite a problem due to the complexity of location. These dimensions were located from the main shaft of the mechanism and had to be correlated to the case itself. The tolerances ranged from plus or minus .002 to a maximum of plus or minus 1/64".

Machining Operations

Figure 7 shows the use of a router with a carbide mill machining the cash drawer opening and a view of the keyboard opening which had been previously completed. This keyboard opening was machined on a fixed table router using a carbide milling cutter.

Figure 8 shows a view of our drilling and routing fixture. All of the routing and drill faces were oil hardened tool steel inserts fastened to the jig frame by cap screws. In most cases, especially for the "D" slot openings, extra length carbide cutters were used and we located on the routing plate with the shaft of the mill itself.

The molding and preform problems were many and complex and time does not permit going into detail. However, the normal modifications were made on the preform screens and finally the preforming was a combination of both hand and automatic fabrication. We found that molding temperatures were extremely critical, and affected both the moldability and the release of the part. Since the part had to be painted, the use of lubricants during the molding operation was prohibited.

Choice of Fillers and Resins

The choice of filler and resins was extremely important due to the length of draw and the design of the part itself. The pour pattern was of extreme importance and finally solved after much experimentation!

Figure 9 shows the mold open with the preform in place at the start of the pour pattern. The preform weight is approximately two pounds six ounces and the resin filler charge approximately four pounds six ounces. The resin is Vibrin 117 with inhibitor with Cabosil added to prevent run off and pregelling. The catalyst is 1/4 of 1% B.P.O.

Normally at the completion of the molding, our major problems would have been solved. Here they began anew with the complicated finishing consisting of the routing of the cash drawer opening, the routing of the keyboard and mechanism opening, and the drilling of lock slots and attachment holes. This accomplished, we then faced a relatively new and more baffling problem, that of applying a void-free paint finish on a molded reinforced polyester fiberglass part. The finish had to be applied by baking the part at 185° to 205° for twenty minutes in order to achieve the necessery texture and hardness required.

One of the many problems was to prevent the warpage of the piece during the baking operation. This was solved by the fabrication of shrink fixtures incorporated in this baking cycle. At the outset, we used multiple prime coats and intermittent sanding between coats. Later we were successful with the use of a light sanding and a seal coat prior to the application of the baking enamel. ★ ★

The Resistance of Glass Fiber Reinforced Laminates to Weathering

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THE IMPORTANCE of the resistance of plastics to weathering needs no comment, but we do need to consider what sort of data we should like to have and what sort we are likely to get. To provide data of maximum utility, a weathering program should include a variety of materials in order to permit unequivocal comparisons among plastics of different compositions. The program should utilize several exposure sites in order to demonstrate performance under a reasonably wide variety of global or at least national conditions. Time intervals up to ten or twenty years would be preferable. A considerable assortment of mechanical tests and some additional physical tests should be performed after exposure.

Very serious practical considerations have required that all weathering programs make significant compromises with this ideal inclusiveness. The closest approach to totally satisfactory programs are those reported in references 1 through 5, but none of these has involved exposures beyond three years, and none has included as extensive a variety of property determinations as we could wish. However, all did include a variety of exposure sites, a variety of materials, and a reasonable variety of property determinations.

In practice, we shall probably never have weathering programs which approach ideality much more closely than these have, because the cost of a truly all-inclusive weathering program would be very great. In addition, the relatively rapid development of significantly different materials makes part of the plastics put on exposure obsolete by the time the data are published, and data on the newest types of materials will inevitably be available only after several years.

Accordingly, we have to recognize that in connection with resistance to weathering, the data will never be as complete as we should like or as we really need. We shall always have to make the best of what data we have and shall always have to do as much as we can to surmise shrewdly and predict rationally on the basis of the proven facts on hand.

With these circumstances in mind, this article is presented as a review of the best data known by the author to be available and as an interpretation of those data as far as analysis seems to permit. Since most of the especially complete references on the subject are government reports which have not been published in the literature, this presentation may also provide some service in calling attention to the existence and availability of these data. All of the government reports listed are available to the public through the Office of Technical Services, Department of Commerce, Washington, D. C. Reference 6 is available in limited quantities from the Building Research Institute, National Academy of Sciences, Washington, D. C. Although this current journal article includes data derived from these reports, the reports themselves contain vastly more data than are presented here. For example, reference 2 contains about twelve hundred pages of tabulated original data, and reference 5 contains five pages of tabulated condensed data. Several of the reports contain extensive information on varieties of plastics which will not even be mentioned in this article. Accordingly, this presentation should not be understood by any means to be a complete review of the references listed.

Three Year Exposure

Let us start with the data on strength properties after three years' exposure. The first of these data are from reference 2. The specimens were exposed at an angle of 45° to the horizontal, facing due south. Exposure sites were Point Barrow, Alaska; New York City; White Sands, New Mexico; and the Panama Canal Zone. Each of the values given is the average of five determinations. Mechanical properties after three years' exposure are shown in Table 1 for a glass fabric reinforced laminate bonded with Selectron 5003. This binder is described as a mixed maleic-phthalic acid ester cross linked with styrene, and is one of the most widely used types of polyester. The data in the second line consist of the lowest values observed at any one of the four sites. The losses are considerable but not catastrophic, being less than 20% for

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Table 1

Properties of Polyester Laminate

(5/32" thick; 9 layers of glass fabric #164; Selectron 5003 as binder)

	Tensile Strength (lbs. sq. inch)	Tensile Modulus (lbs. sq. inch)	Flexural Strength (lbs. sq. inch)
Original	32,000	2.33×10^6	39,000
Worst after three years' exposure	28,000	1.97×10^6	28,000
Worst, excluding arctic and tropic	30,000	2.27×10^6	32,000
Worst, excluding arctic	28,000	1.97×10^6	32,000
Unexposed, after three years	32,000	2.62×10^6	38,000
			Ref. 2

Table 2

Properties of Polyester Laminate

(5/32" thick; 9 layers of glass fabric #162; Bakelite 16631 as binder

	Tensile Strength (lbs. sq. inch)	Tensile Modulus (lbs. sq. inch)	Flexural Strength (lbs. sq. inch)
Original	31,000	1.98×10^6	35,000
Worst after three years' exposure	23,000	1.91×10^6	26,000
Worst, excluding Arctic	24,000	1.91×10^6	29,000
Worst, excluding tropic	23,000	2.00×10^6	26,000
Unexposed, after three years	34,000	2.46×10^6	36,000
			Ref. 2

Table 3

Warp and Twist of Polyester Laminates

%, After outdoor exposure

Laminate	11 mos. at Dayton, Ohio	24 mos. at Dayton, Ohio	11 mos. in Florida
6 layers of glass fabric # 162, cross laminated; 50% Laminac P-4122 binder	1.3	5.1	2.4
6 layers of glass fabric #162, cross laminated; 46% Marco 1A binder	1.6	2.5	0.7
40 layers of glass fabric #112, parallel laminated; 45% Plaskon 900 binder	0	0	0.1
			Ref. 4

Table 4

Properties of Glass Fabric Phenolic Laminate

(1/8" thick; NEMA Grade G, B.)

	Tensile strength (lbs. sq. inch)	Tensile modulus (lbs. sq. inch)	Work to Produce Failure (ft.-lbs. in)
Original	24,000	2.00×10^6	15
Worst after three years' exposure	18,000	1.83×10^6	10
Unexposed after three years	20,000	1.90×10^6	—
			Ref. 1

Table 5

Properties of Polyester Laminate

	Original properties		% Change in properties after 11 months' exposure in Florida		% Change in properties after 23 months' exposure at Dayton, Ohio	
Laminate	Flex. strength (lbs. sq. inch)	Flex. modulus (lbs. sq. inch)	Flex strength	Flex. modulus	Flex strength	Flex. modulus
6 layers of glass fabric # 162, cross laminated; 50% Laminac P-4122 binder	16,000	0.63×10^6	23	32	1	18
6 layers of glass fabric #162, cross laminated; 46% Marco 1A binder	25,000	1.75×10^6	18	8	9	10
40 layers of glass fabric # 112, parallel laminated, 45% Plaskon 900 binder	40,000	2.26×10^6	8	10	16	10

tensile strength or tensile modulus and less than 30% for flexural strength.

If we are considering materials for use within the limits of the continental United States, there are few areas which would have arctic conditions, and only southern Florida and possibly parts of the Gulf Coast would have tropical conditions. Outside these areas, the values in line 3 would be applicable. Losses in temperate and desert sites were considerably less than those in arctic and tropical locations.

The data in Table 2 are for another laminate from the same test program. The binder in this instance was Bakelite 16631, described as a maleic acid polyester cross linked with styrene. Note that this is not a phenol-formaldehyde binder. The strengths were not as high, either originally or after three years' exposure, but none of the losses during exposure exceeded 30%.

Accordingly, it appears that an allowance of 20% will be generally safe for losses in mechanical properties during an outdoor exposure of three years, and that an allowance of 30% will be more than safe.

Dimensional Stability

There are additional properties in which a design engineer is interested besides strength and stiffness characteristics. One of these is dimensional stability. Table 3 shows data on warp and twist taken from reference 4. In the first place, the terms "warp and twist" need defining. In this work, a straight line was run from one end of a test panel to the other end, and the deviation of the panel from this straight line was measured. Warp was then reported as the percent which the deviation constituted of the length. Twist was measured similarly except that it was determined by running a diagonal line from one corner to an opposite corner. Neither the materials, the exposure sites, nor the exposure times were the same in this program as in the program reported in reference 2. However, the compositions were of the same general types, and the best composition showed essentially no distortion at all. The other compositions showed distortions which would be serious for some applications but not for others. So, distortion does not seem necessarily to be serious, and compositions can be selected which will be free of significant warp or twist. We shall see later that the best composition in this respect is favorable in other properties as well.

In Table 4 are shown data on a glass fabric reinforced laminate bonded with phenol-formaldehyde resin. These data are taken from reference 1. All conditions were the same as in reference 2 except that the arctic exposure was at Fort Churchill, Canada, rather than at Point Barrow, Alaska. Strength and stiffness losses were less than 30%, but losses in toughness were slightly over 30%. These data agree with the general impression that phenol-formaldehyde polymers do not weather as well as do polyesters, but later we shall see some interesting favorable developments in this connection.

We might consider briefly the apparent significance of these data taken together. In the first place, it should be mentioned that the rate of deterioration with time can be determined from the original data, although not from the condensations of these data presented here. All of the laminates were deteriorating more slowly at the end of three years than after shorter time intervals. Accordingly, the materials did not seem to be about to deteriorate catastrophically in the foreseeable future.

In the second place, all of these laminates were without pigment or filler. In practice, of course, both pigments and fillers have a number of advantages in improving properties as well as in securing economy. In addition, it is practically certain that pigments will provide considerable screening from ultra-violet light, and will provide better resistance to weathering.

Angle of Exposure

An application of laminates for walls or sheathing would involve the use of a material at a vertical angle and this would be expected to result in less serious exposure than the 45° angle used in all of these tests. Accordingly, the angle of exposure in these tests is severe, and there may be numerous applications in which a less severe angle can be anticipated.

The effects of cut edges on exposed fibers should be considered. Most of these test panels were placed outdoors as molded. Accordingly, the panels had slight beads of polymer at the edge which sealed in the ends of the glass fibers. In normal use, most edges are trimmed, and it is often necessary to drill holes in the laminates. This exposes the ends of the fibers at the cut surfaces. It would seem probable that this exposure might result in more rapid deterioration than was observed in the test programs reported. However, the results given by Pusey and Carey (Modern Plastics, 32 133ff (1955) March) on moisture absorption and related problems in glass fiber reinforced laminates showed that these exposed edges should not have any effect.

Accordingly, it would appear that the results reported in Tables 1 through 4 can appropriately be taken as representative and not as especially favorable instances. If anything, the data reported were taken after unusually severe exposure.

One additional set of data seems to offer corroboration of the information in Tables 1 and 2. These corroborative data are shown in Table 5 and are taken from reference 4. The laminates are the same as those discussed in connection with warp and twist. No losses in excess of 20% were observed after two years' exposure. It will be seen that the laminate which showed minimum warp and twist also had the highest strength and stiffness values both initially and after exposure. In any case the trends observed earlier seem to be corroborated; an allowance of 20% for loss in properties during three years outdoor exposure will generally be adequate, and a loss of 30% will be conservatively safe.

More Favorable Picture

This about exhausts the performance which has been proven on the basis of three-year tests at a number of sites and with several materials tested simultaneously. So we turn now to considering what evidence we have for anticipating that future tests may give us an even more favorable picture of resistance to weathering. The data in reference 5 are helpful in this connection. These are from a program conducted by the Forest Products Laboratory for Wright Air Development Center. A number of different laminate compositions were tested simultaneously and at a variety of sites. The arctic site was College, Alaska, in the interior of the territory, and the temperate site was Madison, Wisconsin. A desert site in New Mexico and a tropical site in the Panama Canal Zone corresponded closely with the desert and tropical sites used in the other programs.

An important difference in the materials used by the Forest Products Laboratory is that they were prepared about six years later. In references 1 through 4, we are considering laminates made ten years or more ago. Those laminates were made by the best available techni-

ques at that time, but there have been great changes since. In particular, there have been important changes in surface finishes. These changes have resulted in much higher strength values in laminates, but the resulting products may deteriorate more or less rapidly than the earlier laminates. The Forest Products Laboratory's program used materials with these more recent finishes and with correspondingly higher initial values. The test data show the deterioration after one year of weathering.

Table 6 shows the data for one laminate. This laminate was made with Selectron 5003, the same binder used for the laminate reported in Table 1. In the first place, the initial values are higher as expected. In the second place, the maximum loss was 5%.

Comparison of Laminates

The first question is how this loss compares with that of the laminate in Table 1 and reference 2 for the same time interval. A comparison is shown in Table 7. It is immediately apparent that the more recent laminate has both higher absolute strength values and higher percent strength retention after one year than was shown by the earlier laminate with the same binder in reference 2. This would lead us to expect both higher absolute values at the end of three years' exposure and higher percent value retention than observed previously. The Forest Products Laboratory's program is continuing, and in due course will produce conclusive proof, but in the meantime we can reasonably surmise that the loss and strength will be considerably less than 20% and that the ultimate strength values will be considerably higher than those reported in Table 1.

Considering now the other data available in reference 5, Table 8 has been prepared to show this information in a greatly condensed form. All of the laminates were made with the same number of layers and with the same construction of glass fabric. Differences are in binder, percent binder, and in finish of the fabric. Curing conditions were varied as appropriate for each binder. Strength retention is given as the lowest percent retention observed at any one site.

The materials fall into several categories. Selectron 5003 and Plaskon 911-11 are polyesters. The Selectron was cross linked with styrene and the Plaskon was cross linked with diallylphthalate. The Dryply 81 is a polyester material developed with emphasis on certain advantageous fabricating characteristics. The PDL-7-669 and Vibrin X-1047 are polyesters developed for superior retention of properties at elevated temperatures. The PDL-7-669 contains triallylcyanurate and is now designated as Laminac 4232. The Bakelite BV 17085 is a phenol-formaldehyde binder with superior retention of properties at elevated temperatures. The Epons are epoxy binders, the 828 being a low molecular weight and the 1001 a high molecular weight material. The Silicone DC-2104 was the standard silicone laminating resin sold by Dow-Corning at that time.

Polyester Performance

Now considering percent property retention, the polyesters did fairly well. The Selectron 5003, cured with a normal elevated temperature cure, and the Dryply 81 were clearly the most durable. The high temperature polyesters showed much less satisfactory property reten-

Table 6

(½" thick; 12 layers of glass fabric # 181; 36% Selectron 5003 as binder)

After 12 mos. exposure in	Tensile Strength	Comp. Strength	Flexural Strength	Wet Flexural Strength	% H 0 lbs.
		lbs. per sq. in.			
Unexposed original	45,300	33,700	56,400	53,200	0.60
		percent of control			
Alaska	108	144	109	108	0.69
Panama	107	140	112	106	0.62
N. Mexico	99	147	104	101	0.77
Florida	103	150	105	95	0.82
Wisconsin	105	136	109	107	0.66
Unexposed control	99	111	98	102	0.75

Ref. 5

Table 7

Laminates with Selectron 5003

	Data from Ref. 2		Data from Ref. 5	
		Tensile Strength		
Original	32,000	—	45,300	—
After 1 year's exposure	29,000 to 31,000	91% to 97%	44,800 to 49,000	99% to 108%
		Flexural Strength		
Original	39,000	—	56,400	—
After 1 year's exposure	31,000 to 85,000	80% to 90%	55,800 to 63,200	99% to 112%

Ref. 2 and 5

tion, but showed only moderate loss in the most important property tested—wet flexural strength at elevated temperature. The phenol-formaldehyde laminate showed very good property retention, a great improvement over the durability shown some years previously in the data in Table 4, and in comparison with the generally anticipated weather resistance performance of phenolic polymers. The epoxies and the silicone showed moderate percent property retention.

The actual strength values after one year's exposure are shown in Table 9. As well as having high percent strength retention, Selectron 5003 with a normal elevated temperature cure is seen to have superior strength values in almost all instances relative to all the other polyesters. Dryply 81, which had excellent percent strength retention, has relatively low actual values. The high temperature polyesters apparently achieve their advantage under those conditions at the expense of strength values at room temperature as well as of percent property retention. However, the retained strength when wet and at 500°F after one year's exposure is very considerable, and it is for this property in particular that the materials are intended. The absolute values obtained with the phenol-formaldehyde binder are much more variable from property to property. The epoxy which had the better percent retention also had the better absolute values and, after one year's exposure, was, in general, the strongest laminate of all. The silicone bonded laminate

Table 8
Percent Strength Retention of Laminates After 1 Year's Outdoor Exposure

Identity of Binder	% Binder	Finish on Fabric	Tensile Strength	Compressive Strength	Flexural Strength	Wet Flexural Strength	Wet Flexural Strength at 500°F	% Water Absorption
Selectron 5003 (elev. temp. cure)	36	Garan RS-49	99	114	98	95		0.82
Selectron 5003[1] (rm. temp. cure)	38	"	95	141	101	80		0.84
Plaskon 911-11	40	"	91	105	88	80		1.21
Dryply 81	40	"	109	110	117	108		1.54
PDL-7-669	37	"	76	93	66	70	82	3.27
Vibrin X-1047	31	"	70	90	68	61	91	2.36
Bakelite BV 17085	35	Volan A	99	97	100	94	99	1.53
Epon 1001	35	"	88	111	91	86		1.11
Epon 828	36	"	80	99	88	89		1.02
Silicone DC2104	37	Heat cleaned, no finish	86	100	94	97	94	3.94

[1]No data at Panama, Florida, or Wisconsin

Ref. 5

Table 9
Strength of Laminates After 1 Year's Outdoor Exposure

Identity of Binder	% Binder	Finish on Fabric	Tensile Strength	Compressive Strength	Flexural Strength	Wet Flexural Strength	Wet Flexural Strength at 500°F	% Water Absorption
Selectron 5003 (elev. temp. cure)	36	Garan RS-49	45,000	34,000	55,000	51,000		0.82
Selectron 5003[1] (rm. temp. cure)	38	"	42,000	31,000	53,000	44,000		0.84
Plaskon 911-11	40	"	39,000	43,000	50,000	43,000		1.21
Dryply 81	40	"	37,000	33,000	49,000	33,000		1.54
PDL-7-669	37	"	26,000	29,000	30,000	28,000	23,000	3.27
Vibrin X-1047	31	"	28,000	23,000	34,000	28,000	19,000	2.36
Bakelite BV 17085	35	Volan A	27,000	43,000	51,000	49,000	9,800	1.53
Epon 1001	35	"	51,000	51,000	64,000	51,000		1.11
Epon 828	36	"	38,000	43,000	50,000	34,000		1.02
Silicone DC2104	37	Heat cleaned, no finish	29,000	14,000	26,000	25,000	9,700	3.94

[1]No data at Panama, Florida, or Wisconsin

Ref. 5

was especially low in two properties.

Of course, the values in Tables 8 and 9 are those obtained after an exposure of one year. In general, we need to determine durability outdoors for longer periods of time. In due course, the Forest Products Laboratory will presumably publish data covering three years of exposure. But, what can we now reasonably estimate as prospective values at the end of that time, anticipating that the published data will eventually support our surmise?

Highest Strength Material

Original and estimated property values after three years' exposure are given in Table 10 for the highest strength material of each type. These estimated values are given at the author's risk and not on the basis of conclusions drawn by the experimenters in references 1 through 5. In Table 10, a 20% loss of strength has been allowed for deterioration by Selectron 5003, Dryply 81, and Epon 1001, except that 30% loss was allowed for loss in wet flexural strength by Epon 1001. The choice of percent is based on the observations earlier in this paper. The greater percent allowed for the wet flexural strength of Epon 1001 is based on the fact that 14% had been lost during the first year. In the case of the Laminac, the prognostication of prospective values is much more uncertain; 40% loss has been predicted, while 34% was actually lost in the first year in one property. Predicted values for the Bakelite and silicone laminates are based on anticipated total losses of not over 20% in three years.

Publication of actual observed results will be necessary before any of these values can be accepted as final, but, if estimates must be made, these would seem to be reasonably well supported. In any instance, it appears almost certain that the reliable values now established experimentally in Tables 1 through 5 will almost surely be raised as further test results become available. It also appears that the best polyesters and phenolics may be demonstrated to lose considerably less than 20% during a three years' outdoor exposure. A maximum percent loss of 20% or slightly more may well become established for epoxies and silicones. Our initial estimate of about 20% loss of properties and not more than 30% loss still appears likely to become increasingly reliably established except in the case of polyesters which are developed primarily for their elevated temperature properties. ★ ★

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Table 10

Predicted Strength Values

Identity of Binder	% Binder	Finish on Fabric	Tensile Strength	Compressive Strength	Flexural Strength	Wet Flexural Strength	Wet Flexural Strength at 500°F
Selectron 5003							
Original	36	Garan RS-49	45,300	33,700	56,400	53,200	
after 3 yrs.' exp.			36,000	27,000	45,000	43,000	
Dryply 81							
Original	40	"	37,500	32,800	49,300	32,800	
after 3 yrs.' exp.			30,000	26,000	39,000	26,000	
Epon 1001							
Original	35	Volan A	57,700	51,000	70,500	59,100	
after 3 yrs.' exp.			46,000	41,000	56,000	41,500	
Laminac 4232							
Original	37	Garan RS-49	34,700	30,800	44,800	39,700	28,400
after 3 yrs.' exp.			21,000	18,000	27,000	24,000	17,000
Bakelite BV 17085							
Original	35	Volan A	27,400	44,900	51,300	48,700	9,950
after 3 yrs.' exp.			22,000	36,000	40,000	39,000	8,000
Silicone DC 2104							
Original	37	Heat cleaned,	34,600	14,200	27,300	26,200	11,100
after 3 yrs.' exp.		no finish	28,000	11,000	22,000	21,000	8,900

Machinery Maintenance

J. G. Thompson

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Ashland, Massachusetts

Maintenance is ordinarily regarded as something to do when a breakdown happens. Men then go to work at a feverish pace and under great pressure. Production is held up and the profit margin takes a beating.

In a true sense, maintenance means prevention,—prevention of breakdown or at least minimizing the possibilities of breakdowns. A change in attitude about this important work is therefore clearly indicated. With this different viewpoint, emphasis will be on maintenance **before**, rather than **after** something happens.

The advantage gained is that the molder will choose the time for doing an important overhaul job instead of being forced to do it by an emergency which always happens at the worst time possible.

In order to plan maintenance work, it is necessary to know what to plan for. To this end, inspections should be made at fairly frequent intervals. A careful appraisal of the machines and their condition should be written with particular attention to wearing surfaces, stressed members, safety devices, pumps, and everything that should be included in a thorough examination.

Tag for Action

To clinch the matter and insure action at an appropriate time, a tag could be attached to the equipment calling attention to any proposed overhaul. In this way everybody is informed, and use of the machine on a long production run, or for work that may tax the machine to the limit of its capacity, is prevented.

The interval between inspection and actual work then allows time for planning and procuring of replacement parts.

Maintenance may be divided into two classes. First, there is routine maintenance performed daily which takes care of lubrication, replenishment of hydraulic oil, checking pump pressures, checking oil leaks at various joints, checking packing, checking safety devices, and making such adjustments as may be practicable.

Second, there is the appraisal inspection which has to do with major repairs and overhaul. Records of previous inspections and repairs, made or contemplated, should be referred to at every inspection and extent of progress of defects carefully noted.

The previous records provide clues as to when a machine must be shut down for replacement of a vital part and thus forestalls a serious breakdown with its consequent confusion, lost production and extra expense for which nothing has been planned.

Safety Devices

A very important item that comes under the heading of maintenance is safety devices. The maintenance man must keep these in perfect working order. Every machine has such devices, but sometimes operators tamper with them in the mistaken notion that he makes his machine easier to run. He ignores the fact that the machine cannot think while he himself forgets to think. The repetitive cycling and monotony of operation sort of lulls him into a false sense of security and dulls his alertness. The safety device is there to substitute for this lapse of alertness and prevent injury. The importance of this must be impressed on both the operator and maintenance man, and the latter should never lose sight of his responsibility to keep devices in perfect working order.

Maintenance is a never ending responsibility. As long as friction between two moving surfaces exists, there will be wear and change. As long as machine members must be stressed fatigue of the metal will eventually develop. Trained and experienced personnel should be available. This applies most emphatically to the supervisor of the maintenance crew. He should be well grounded in the mechanics of presses and understand the why and wherefore of machine construction and be prepared to maintain them.

It is a sad and dangerous condition when the man on the job is not fully competent, as happens sometimes. To the understanding observer, incompetence shows up in every motion. Usually a fault-finding man reveals his lack of ability and knowledge because he is merely establishing alibis for incomplete or poorly done work. He is like the "man who has no music in his soul and is fit for treasons, stratagems and spoils, let no such man be trusted." ★ ★

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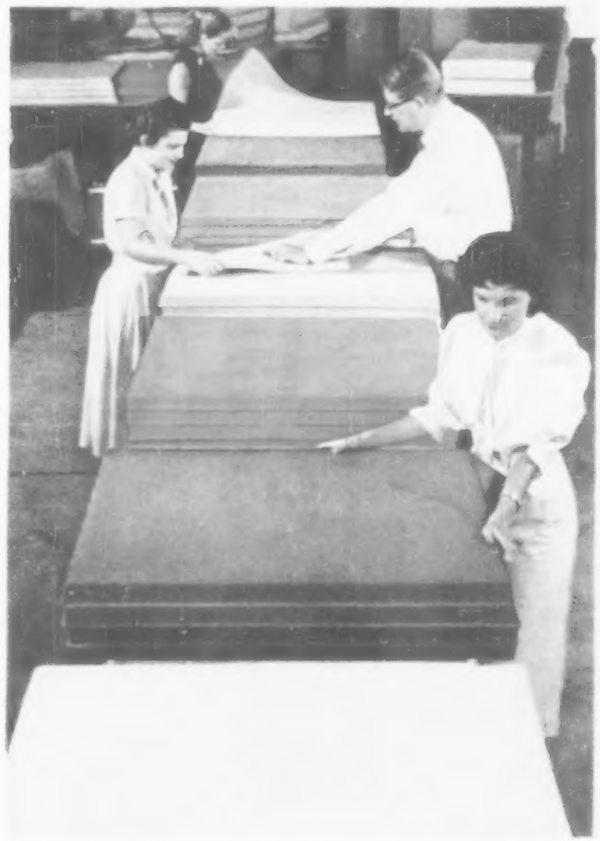

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Thermocouple Location and Watt Density in Injection Molding Heating Chambers

Robert Dahl and Robert McKee

The Dow Chemical Co.
Midland, Michigan

Accurate control of temperature requires an accurate sensing of the temperature. The thermocouple junction must be clean and in firm contact with the metal. All connections between thermocouple and control instrument must be tight, with clean contact surfaces. These connections should be as few as possible.

This leaves one question: Is the thermocouple located where we want the temperature controlled? In an injection molding machine two or three controllers are available, hence there are that many control thermocouples. The problem is to locate these control thermocouples so that by controlling the temperatures at these few places, we also control the temperatures elsewhere. This requires several things: **1:** Correct matching of the watt capacity of the heaters to the demand. **2:** Correct location of the control thermocouple. **3:** Accurate communication between thermocouple and control, and **4:** Suitable control action. Item 3, communication, is a matter of good workmanship, right length of leads, firm connections, and accurate calibration of the controller. Item **4** is outside the scope of this report. Several reputable instrument companies market controllers whose action is adequate for good temperature control, provided the other conditions of temperature control are met.

Most of the people involved in the design or use of injection molding equipment know that the demand for heat, and consequently the temperature, is not the same all over the heating chamber. A large amount of heat is needed in the back where the hot barrel joins the water cooled feed sleeve. Where the unheated plastic first comes in contact with the heating surface a very high flow of heat occurs due to this steep temperature gradient. The heat demand decreases from here on until the spreader mounting point is reached, where the heat supplied to the spreader makes its demand.

In addition to the demand variation along the length of the barrel, the top has been observed to run hotter than corresponding locations on the side or bottom. This is apparently a result of air convection, with cool air impinging on the bottom, flowing along the sides, and forming an "eddy" of hot air at the top of the barrel.

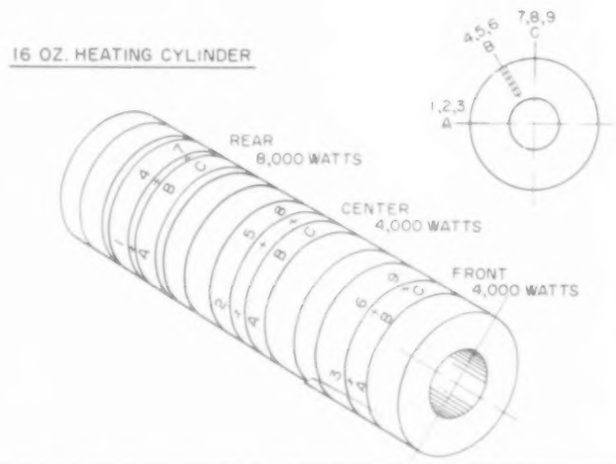
Finally, when heat comes from electric elements clamped on the outer surface of the chamber, there is a temperature gradient accompanying the flow of heat from these bands into the interior of the chamber.

The variations in temperature and watt demand on the heating chamber make it immediately obvious that one heater band and one control thermocouple will not be adequate. Extra heater bands and controllers mean extra expense. The problem is, what is the minimum number of control zones (heater band-thermocouple combinations) that will control the temperature within acceptable limits?

Experiments on Various Machines

Many injection molding machine manufacturers provide three zones of heat on the heating chamber. The first machine we tested was of this type. The heating chamber itself is of familiar design; the smooth spreader is held in place by a shoulder on its downstream end. The barrel is of uniform diameter with the Calrod heaters wrapped in grooves and staked in place. The rear zone has 8000 watts capacity, the center and front zones 4000 watts each. As in Figure 1, the control thermocouples are located in the side of the cylinder, drilled about half way in

Figure 1.



This paper was presented at the Thirteenth SPE Technical Conference.

Figure 2.

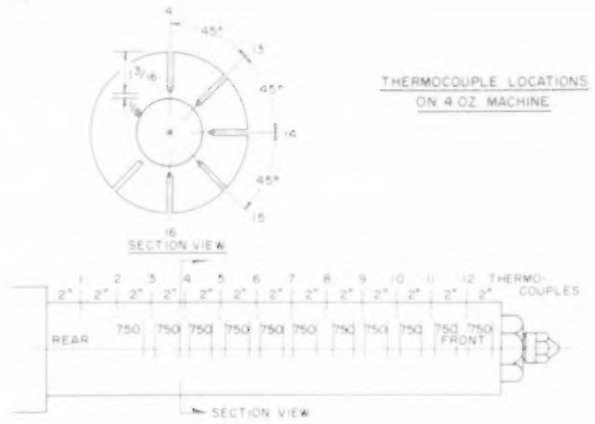
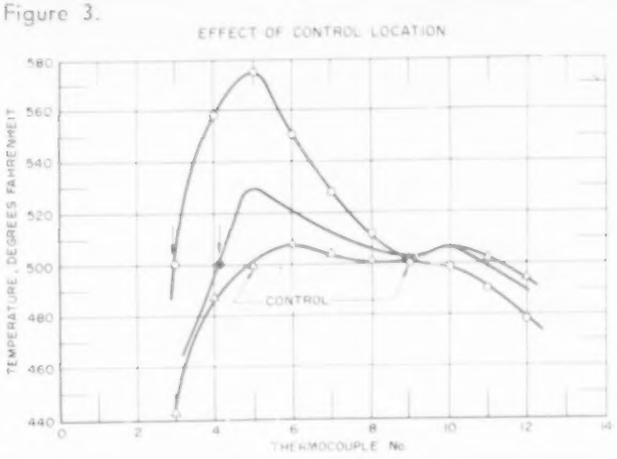


Figure 3.



toward the inner wall. For these tests, six more holes were drilled in the same vertical planes as the standard thermocouples, one set on the top and one set about halfway up.

The first step in the test was to run the machine on a constant cycle, while the sets of thermocouples were moved in combinations to make certain that all of the thermocouples read identically. In the course of these tests, the heaters were controlled by thermocouples in the side, top, and halfway between, with the results shown in Table I. These measurements all show that the top temperature is about 10°F. higher than that at the side.

The additional thermocouple holes described above were originally drilled to a depth of ¼", then deepened in steps to a final depth of 1-¾". At each depth, the machine was operated on the same cycle and heater setting, measuring the heater energy input and plastic temperature. Results in Table II show that the thermocouple is cooler when installed more than 1" deep and consequently calls for more heat, resulting in a higher plastic temperature and more heat input. The plastic temperature is higher when control is at the side, although this difference is small when the control is shallow.

The heating chamber of this machine is usually fitted with an asbestos-lined stainless steel cover. To check the effectiveness of this cover, it was removed and a run made as before. Table III shows that the cover saves 1,325 of the 5,175 watts needed for this cycle, or 25.6%. The measured plastic temperature was higher when the cover was removed, (more heater "on" time means higher temperatures under the heater bands) but the difference is not significant. The effects of these reduced temperatures on the life of the heater bands is undoubtedly balanced by the more rapid cycling, which would seem to shorten life. However, if the heaters are controlled by varying the voltage, use of a cover means generally lower voltage, and longer life.

To study the effect of control location along the barrel another heating chamber, smaller, but of similar design, was used (Figure 2). Here, the original heater bands were removed and replaced with narrow band units so that thermocouples could be installed 2" apart along the barrel. These thermocouples are inserted to a depth of 1". At one location, thermocouples were installed 1-3/16" deep at top, quarter, side, quarter, and bottom. The heater bands have a capacity of 750 watts each.

It was found that when operating with a 4 ounce shot on a 60 second cycle with 500°F. heater setting that the control thermocouple was effective in controlling the temperature only in its immediate vicinity. The "zone of control" has been elsewhere defined as 1-½" from the control thermocouple and our results confirm this (1). Figure 3 shows that high mid-barrel temperatures result when the control thermocouples are located near the centers of

Table I

EFFECT OF CONTROL THERMOCOUPLES AT VARIOUS LOCATIONS

1"DEEP

CONTROL COUPLES IN HOLES	READING OF THERMOCOUPLE No.									
	1	2	3	4	5	6	7	8	9	TA
123 IN A	500	500	501	514	514	517	520	522	522	403°F
456 IN B	490	490	490	501	501	505	508	509	509	398
789 IN C	483	482	481	495	493	496	500	499	500	391
456 IN A	515	513	513	499	500	500	523	521	520	404
789 IN A	510	511	512	511	509	508	500	500	500	404
789 IN B	489	484	481	502	498	499	500	500	500	397
123 IN C	500	501	502	499	500	501	490	488	488	398
123 IN A	500	501	501	519	512	518	527	522	526	406
456 IN C	483	489	485	500	500	501	502	504	505	398

Tables II and III

TEMPERATURE AT VARYING CONTROL DEPTH

DEPTH	'A' BTU IN	TA	'B' BTU IN	TA	'C' BTU IN	TA
¼"	—	—	—	—	13,130	403
1"	14,200	403	13,500	400	13,400	406
1 1/16"	14,100	415	13,500	413	13,500	409
1½"	14,500	419	14,050	415	13,400	410
1 3/4"	14,700	414	14,200	409	13,800	409

EFFECT OF B.T.U. INPUT (WITH & WITHOUT SHIELD)

SHIELD	1	2	3	4	5	6	7	8	9	TA	BTU IN
SHIELD ON	471	480	478	482	490	489	501	500	500	404	13,130
SHIELD OFF	472	479	479	480	490	489	500	500	502	407	17,680

their respective zones. The situation is aggravated when the rear control is moved back to get the rear in control.

The foregoing tests were made with a uniform watt density along the barrel; that is, with 375 watts per lineal inch installed capacity. In the next series of tests, the heater bands were rearranged to approximate a distribution of watt density that would correspond to the demand. We soon found that "uniform" temperature would have to be qualified by "within plus or minus ten degrees", for it was not possible to get any closer than that to a truly uniform temperature down the barrel. Another difficulty

Temperature Control Effects

Figure 4.

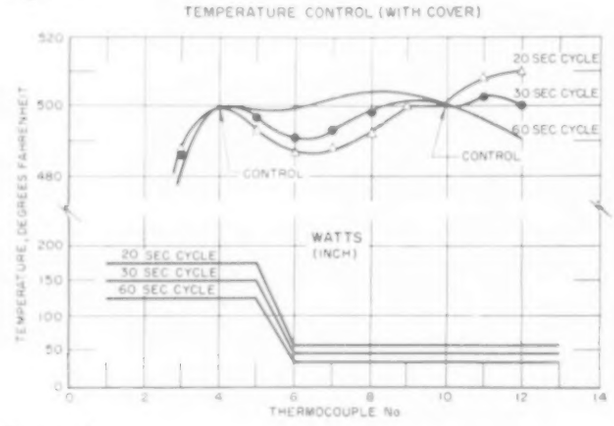


Figure 5.

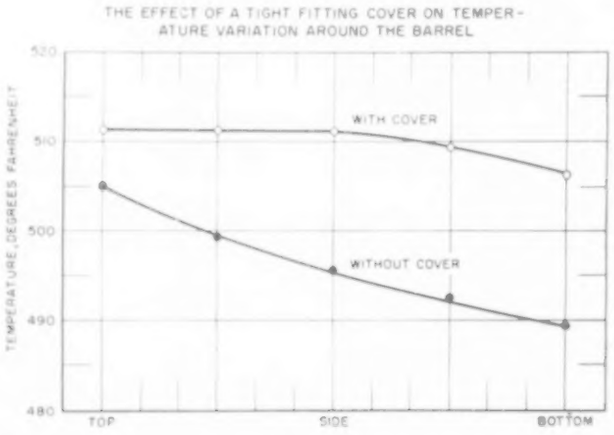
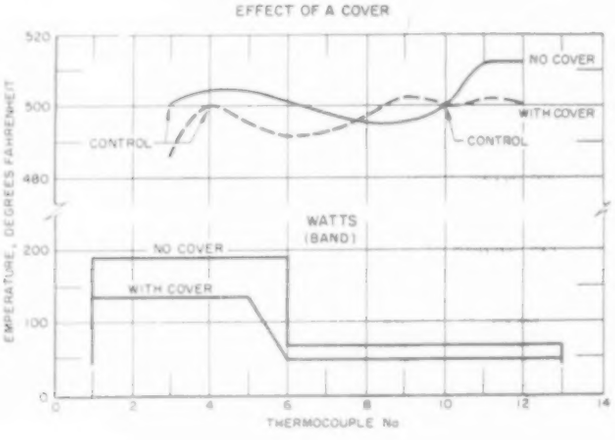


Figure 6.



was that the pattern of demand changes with changes in cycle (Figure 4). An increase in cycle or output rate means that the zone of relatively cold plastic will extend further into the chamber, causing more demand in the center and depressing temperature there. This increase in demand is not felt at the nose, so the increased "on" time of the heater zone will cause high front temperatures.

All of these watt distribution tests were made with an uncovered heater, so the next step was to install a simple cover which consisted of a wrap of asbestos paper overwrapped with aluminum foil. The wrap was joined on the side where the heater connections were made, so there is no opening at the bottom for air to enter, and no opening at the top. A notable result of this was to eliminate the temperature difference between bottom and top of the cylinder, as shown in Figure 5. Another result was the reduction in electric input as mentioned before.

It follows that the radiation from the heater bands will be most reduced where it was originally most intense, i.e., where the "on" time was greatest. The demand was most reduced in the rear zone, and it was necessary to rearrange the heaters to get uniform temperatures again. Figure 6 shows the wattage distribution with and without a cover.

The First Step in Control

The first step in temperature control is to determine the watt distribution best suited to the heating chamber. Our appendix contains a calculation system which will give good basic wattage pattern. Some changes have to be made to this to allow for startup, plastics of different thermal characteristics, and the possibility of running different cycles or shot sizes. Obviously, judgement will always be needed in the final selection of heater bands.

Next, the question of how many zones to divide the heat must be settled. Generally, control thermocouples should not be more than 8" apart, even with wattage well matched to demand. This "rule" means three zones on a heating chamber more than 16" long.

The location of the control point is important, as we have shown. Obviously, the control should be within the control zone. Generally, a location within the center third of the zone is best. If the wattage calculation (or your intuition) shows an exceptionally high or low demand, the control point should **not** be at that point.

The control should not be too close to the heater bands; it will act to limit heater response to demand changes and give lower plastic temperatures. The deep thermocouple (near the plastic) measures most accurately the temperature that we wish to control, but the thickness of metal between heater band and control introduces a time lag which makes for temperature overshoots. Our best results were obtained with the thermocouple junction about halfway in. The combination of a deep and a shallow thermocouple hooked in parallel gives an average temperature, one which reacts quickly to changes in conditions. The parallel hookup will sometimes give drastic improvement in control action.

Finally, the control thermocouple should be installed so that good contact will be maintained. This requires first a clean hole, which can be assured by running a drill bit into the hole and just hitting its bottom. Installing the thermocouple on the top of the cylinder is recommended, because the temperature there is highest. A drop of solder placed in the hole assures good contact and excludes air from the thermocouple tip, reducing corrosion.

A reflective cover of some sort seems to be a good investment, if only for the operator's comfort. We have shown that a tight fitting cover (this means fitted to pre-

vent air circulation; the cover should not touch heater bands or barrel) reduces power costs and improves temperature control. Makers of heating bands are emphatic that the life of the heater and its connections suffer; we have no data to confirm or support this, except that heaters which work less usually run cooler and last longer.

Appendix

The object of these calculations is to predict the wattage density needed along the barrel of the heating chamber to maintain a uniform temperature. We will do this by assuming that the temperature is uniform and calculating the amount of heat transferred to the plastic, the amount radiated into the air, and the amount conducted into the water cooled mount. Our sample calculation will be for the 4-ounce machine which was used for our tests, at a heater temperature of 500°F., 4 ounce shot in polystyrene, and 30 second cycle.

The rate at which heat flows is dependent, for a given material, on the temperature difference, or gradient (2). Most of the heat transfer in a molding machine takes place while the material is not moving, so the temperature gradient will be a function of the original temperatures and the contact time. Heat flowing into the plastic raises its temperature, reducing the temperature gradient and the heat flow. The relation between heat flow and time of contact is shown in Figure 7, for polystyrene at an original temperature of 80°F.

The most convenient technique for calculating heat demand is to follow one shot as it traverses the heating chamber. We assume that the shot retains its identity all the way and that its volume does not change. When first introduced by the injection ram, the shot enters a chamber of 1-⅞" diameter. The volume of the shot is 6.67 cubic inches, so its length is 2.42 inches and its area of contact with the heater wall is 14.2 sq. in. Referring to the chart, we find that 0.50 BTU/in.^{2}, or 7.1 BTU were transferred during the first cycle. At the end of the cycle, the shot will be moved forward a distance equal to its original length. This brings the shot up over the torpedo nose, and the length of the shot is increased to 2.88 inches, its contact area 16.95 in.^{2}. The heat content of 7.1 BTU on 16.95 in.^{2} is equivalent to 0.42 BTU/in.^{2}, just as though this shot, now having more area, were in contact for 23 seconds instead of 30. Adding 30 seconds gives 53 seconds at the end of the cycle, for a total of 0.69 BTU/in.^{2}, or 11.7 BTU. The shot has gained 4.6 BTU during the cycle. The sense of this manipulation is that when the shot is pressed out to a greater area, the cold center is brought closer to the heater wall, increasing the temperature gradient just as though the original shot had been in contact a shorter period of time. The rest of the shot's journey can be summarized:

Cycle	Area	Equivalent Time	Total Heat	Heat Gain
3	19.8 In.^{2}	40.5 Sec.	15.85 BTU	4.15 BTU
4	22.25 "	56.0 "	19.6 "	3.75 "
5	25.6 "	63.0 "	23.45 "	3.85 "
6	7.85 "	94.0 "	7.9 "	0.75 "
			(1.22 oz.)	

The amount of heat radiated from the barrel, when no cover is used, can be calculated with a chemical engineer's method for estimating heat loss from a pipe (3). For a cylinder of 4-½" outside diameter, at 500°F., the heat radiated is 173 BTU/Hr./In.^{2}, or 50.7 watts/inch of length.

When the mount of the heating cylinder is maintained at 100°F. by water cooling, the barrel temperature at the joint is usually close to that; the temperature increasing to the heater setting some distance away. We have assumed that the temperature is 500°F. from a point 6" from the mount (No. 3 thermocouple). To maintain this temperature gradient we supply 207 watts between No. 1 and No. 2 thermocouple and 418 watts between No. 2 and No. 3 thermocouple.

In our calculations we have so far ignored the heat furnished to the plastic by the torpedo; in this machine the torpedo is relatively long and contributes little heat to the plastic except near its mount. The heat transmitted to the torpedo mount can be calculated by assuming a temperature drop to 300°F. at the forward tip. The heat transferred from torpedo to plastic would result in higher temperatures and less heat gain. Where the torpedo is heated and contributes a large amount of heat, this should be figured in each cycle.

Finally, the heat drains during each cycle are added up and converted to watts per inch of length to give the wattage pattern shown in Figure 8. Agreement is reasonably good. Where the actual wattage is higher than calculated, the actual running temperature is also higher, and vice versa. Admittedly, heater bands can not be arranged to match exactly the predicted wattage pattern, but it is a good basic pattern for location of heater zones, location of control points, and understanding of the process. ★ ★

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2. Carslaw and Jaeger, **Heat Conduction in Solids**, Clarandon Press, Oxford—1st Ed., 1947.
3. Kern, **Process Heat Transfer**, McGraw-Hill, 1st Ed., 1950.

Figure 7.

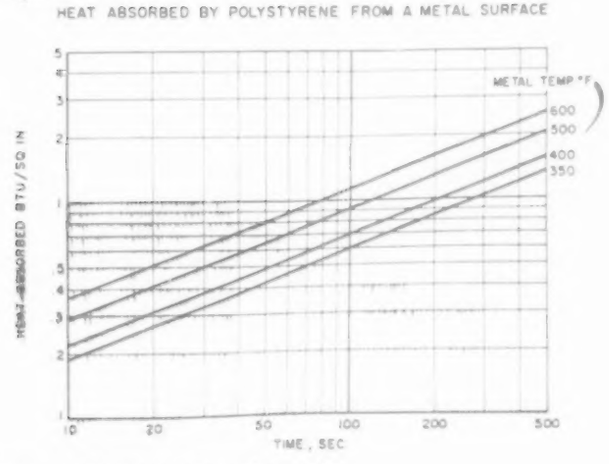
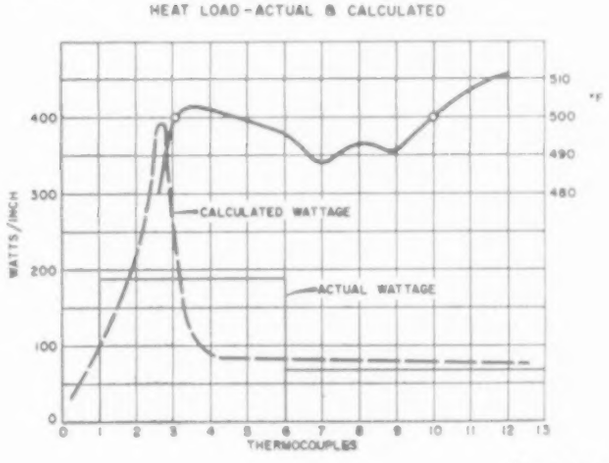


Figure 8.



Frank C. McGrew graduated from the University of Nebraska with a B.Sc. and M.S. in chemistry. He received his Ph.D. in organic chemistry from the University of Illinois on a Chemical Foundation Fellowship. He has been associated with the du Pont Company since 1937, having served as research chemist, research supervisor, and since 1950 as Assistant Research Director in the Polychemicals Department. He is a member of the Society of Plastics Engineers and the American Chemical Society, as well as numerous other American and foreign scientific societies. Polymer chemistry and engineering, particularly as involved in research and development on plastics, have long represented his field of special interest.

Frank C. McGrew

Personal Growth of the Plastics Engineer

Frank C. McGrew
Assistant Research Director
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As an administrator of plastics research for several years, I have had the privilege of observing the personal growth of many an engineer in the business environment. Reflection upon this experience leads me to suggest that the most effective and most satisfying growth of the engineer in the plastics business results from orientation to the needs of the end-user. I believe that this applies equally well no matter in what part of the business environment the engineer is practicing his profession, that is whether it be chemical plant, molding shop, drafting room, laboratory, sales office, or indeed "front office."

In my observation the young engineer is, at the outset of his career, apt to be unaware of the vital role of the customer's wishes in motivating business activity. The college environment is not one which emphasizes this aspect of business life. But I do not suggest that the engineering or scientific curriculum should immediately be modified to include this orientation. It seems to me better that these curricula provide for solid grounding in basic knowledge and techniques required for effective technical performance. Then when the young engineer makes the transition from campus to business environment, it will profit him to become oriented as promptly as possible to the forces that make the wheels of business turn. Remember that the departure from campus is called "commencement". What I am suggesting is that this important turning point is a good time to commence a phase of personal growth that is oriented in a broad sense by the requirements of the ultimate consumer.

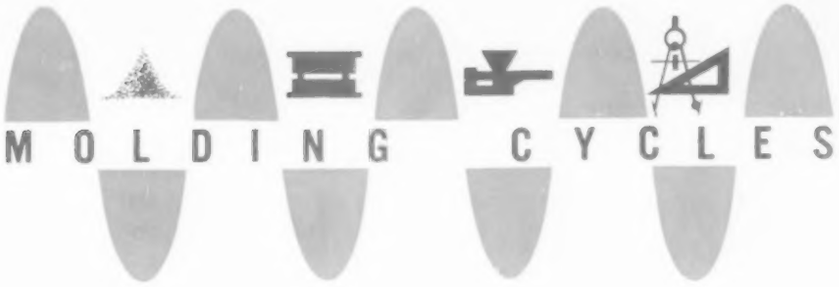
Three ways occur to me of showing how this kind of orientation leads to personal growth: (1) It develops business sense; (2) it confronts the engineer with the greatest technical challenge and opportunity; and (3) it leads to the satisfaction of raising the standards of industry.

What better starting point for the development of business sense is there than appreciation of the profit motive? To put emphasis where it belongs the engineer should realize that there is a chain of profit motives extending from basic manufacturer to final consumer and that the final consumer virtually always has the option of putting his dollars somewhere else. Full appreciation of what he will most readily lay his dollars down for, therefore, seems the most direct way to guide professional activity at any point along the chain in the direction of greater business effectiveness.

The challenge to professional abilities in working for the ultimate consumer is immense. It is not always easy to recognize unfilled needs and especially not easy to recognize needs that will develop in the future. It is harder still to define them in terms that yield readily to technical development. But the opportunity for effective technical contribution to the plastics industry is equally immense. I know of no area of technology where so much remains to be done in realizing the undoubted potentialities.

The satisfaction from professional accomplishment oriented toward the requirements of final uses can be appreciably enhanced by noting that it is part of a greater movement toward higher standards in the industry. Consciousness of the last man in the economics chain standing undecided with the dollar in his hand is our best insurance against inadequate specifications, our constant warning of the dangers of marginal performance, and the source of our strength to resist the temptation of the "quick buck" by cutting corners.

A word to others in management in the plastics business: It seems to me that we can do something useful about this. Those of us who can influence the environment in which engineers work should make it easy for them to respond to end-users' needs. We should, in other words, encourage the development of business sense, bring engineers face to face with the challenge and opportunities of the business, and honor the spirit of serving the consumer as the surest way to progress and enduring business success. ★ ★



Edited by Louis Paggi, *Consultant, du Pont de Nemours & Co., Inc.*

Molding Articles with Thin Sections

Louis Paggi

Practically every molder has, on occasion, had to face the difficult task of filling a mold for items designed with thin sections. Success with such items has often been a matter of accepting inferior quality or re-designing to increase thickness.

Inability to fill thin sections can stem from several sources, among which are:

1. Design of the item.
2. Design of the gate.
3. Mold layout.
4. Insufficient venting.
5. Improper heat distribution on the plastifying cylinder.
6. Slow rate of mold filling.
7. Insufficient pressure.
8. Insufficient clamp capacity.
9. Mold temperature too low.

Design of the Item

While the design of the item cannot always be altered extensively without destroying its intended function, minor alterations in design that will assist in filling the cavity are often possible. These changes may consist of incorporating longitudinal ribs to assist filling of remote sections of the cavity, radii or fillets at all sharp or right angle intersections within the item, or a heavier section such as a shallow well concentric with the gate at the bottom of a box or container.

Design of the Gate

The design of the gate to be used is often dictated by the geometry of the item being molded, however, many pieces can be gated in a number of ways. When faced with the decision as to the most satisfactory gate to use it is best to consider the relative merits of various gates and where they are best suited. The following analysis of gates suitable for thin section molding may prove helpful.

1. The small cross-section gate

Gates included in this category are the full round, half round or rectangular cross-section. They are best suited for low volume cavities and for automatic shearing applications such as in three plate molds or when tunnel-gating is employed. They are not entirely satisfactory for gating into thin-walled and large area cavities where a relatively large volume of material must be injected before the molten plastic hardens. Another shortcoming of this type of gate in certain applications is its tendency to produce a high concentration of stresses at the junction with the piece.

Both of these objections can be partly overcome by a generous radius at the junction between the gate and piece and by holding the length of the gate to approximately $\frac{1}{2}$ the diameter of the gate, i.e., a .030" diameter gate .015" long.

If small cross-section gates must be used, it is well to consider feeding them with a runner of ample diameter to supply well heated material and to attach the gate at or near the center of the melt stream in the runner.

2. The large volume gate

Gates in this category include the fan, diaphragm, ring, flash and flat gates. All of these gates have one feature in common, that is, they provide a relatively large volume of flow into the cavity by employing a wide front with no increase in thickness. Because they are thin they set up quickly and also provide the necessary back pressure into the runner. The main objection to this type of gate is that unless thin, it cannot be broken clean but must be machined off, thus increasing the cost of finishing the item. The advantages offered by these gates, however, often far outweigh the disadvantages. Some of the advantages are:

a. Better control over filling.
b. Permit filling very large areas.
c. Cavities can be filled at lower material temperature or pressure.
d. Less local stress concentration.
e. Minimize core shifting.
f. Ability to hold closer vertical tolerances.
g. Permit better packing of the cavity.

Examples of good applications for the various large volume gates listed above are:

1. For thin sections of relatively small areas and for limited economy of finishing. Use the thin flat gate or the fan gate.
2. For tubular items where wall thickness must be uniform. Use the diaphragm or ring gate as shown in Figures 1 and 2.
3. For extremely large areas and especially where localized stresses cannot be tolerated, use the flash gate as shown in Figure 3. This type of gate has seldom been used although it will out-perform any type of gate in very thin and large areas. Often it can also be used to advantage in heavier sections.

Two disadvantages are higher material consumption and higher finishing cost. In many applications the cost of finishing can be held to a minimum if the "land" or length of the gate is approximately equal to twice the thickness instead of the usual $\frac{1}{2}$ the thickness. The length of this type of gate is not critical simply because any section of the gate must supply material only to that portion of the cavity directly in front of it keeping the volume displacement to a minimum.

Mold Layout

When designing a mold for thin wall items, consideration should be given to the need for high cavity pressure and the need to have hot material arriving at the cavity. This calls for using short runners of generous diameter, minimizing the number of turns in the runner system, and locating the gates at or near the geometric center of the item when possible.

Venting

Because the volume of material required to fill a thin section is relatively small, the need for venting is often overlooked. Slow filling generally cannot be tolerated in thin sections because the plastic hardens rapidly. Thin section cavities, therefore, should be generously vented to prevent the build-up of high back pressure of air during filling.

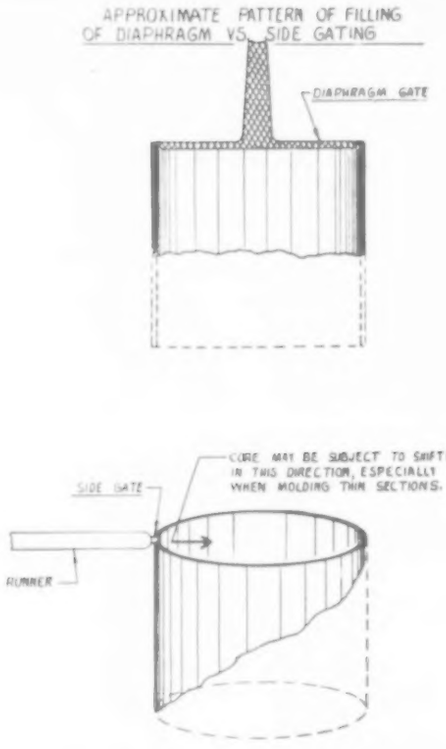
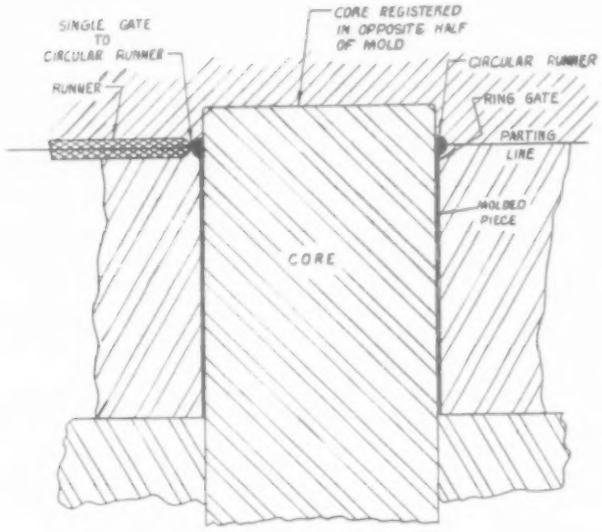

APPROXIMATE PATTERN OF FILLING OF DIAPHRAGM VS. SIDE GATING
DIAPHRAGM GATE
CORE MAY BE SUBJECT TO SHIFTING IN THIS DIRECTION, ESPECIALLY WHEN MOLDING THIN SECTIONS.
SIDE GATE
RUNNER

Figure 1. (left) The diaphragm gate.

Figure 2. (below) The ring gate, for tubular items of uniform wall thickness.



Heat Distribution on the Plastifying Cylinder

Because of the high material temperature usually required to fill thin sections a certain amount of degradation of the material is often encountered. Degradation by heat can be held to a minimum if the exposure time of the plastic to the high temperature is of short duration. This can be accomplished by operating all zones of the plastifying cylinder at a temperature not to exceed the maximum recommended by the material supplier. If additional heat is required it should be applied to the front or "shot" zone only. Overheating of the front zone can often be tolerated for a short period of time, such as may be the time required to take one shot. Overheating of the rear and center zones often result in excessive and unnecessary degradation of the material.

Rate of Mold Filling

Without exception, all thin wall items will require filling of the mold in the shortest possible time. Any condition which interferes with fast injection should be eliminated if possible. Aside from such obvious causes as low material temperature and pressure, a common cause of slow filling is overfeeding of material, or feeding unground sprues and runners to the cylinder.

To determine whether slow filling is caused by machine or mold conditions is a simple matter of taking an air shot between regularly timed cycles. If the rate of injection is appreciably faster for the air shot, the restriction is in the mold.

Low Cavity Pressure

The hydraulic pressure within the injection cylinder is not sufficient evidence of the magnitude of pressure transmitted to the cavity. The design of the plastifying cylinder as well as the quantity and distribution of heat thereon play a major role in the pressure loss within the cylinder. Generally speaking, diverging type cylinders will require a higher wattage per square inch of heater band around the section where the plastic diverges over the spreader than straight bore cylinders.

Successive hot and cold spots along the length of the cylinder, such as may be caused by locating heater bands too far apart, should be eliminated. A considerable loss in pressure can result from just one such cold spot. If a cold spot is suspected, it can be located by raising the temperatures of the individual zones one at a time. The zone having the greatest effect on cavity filling should be scrutinized for balanced heat distribution.

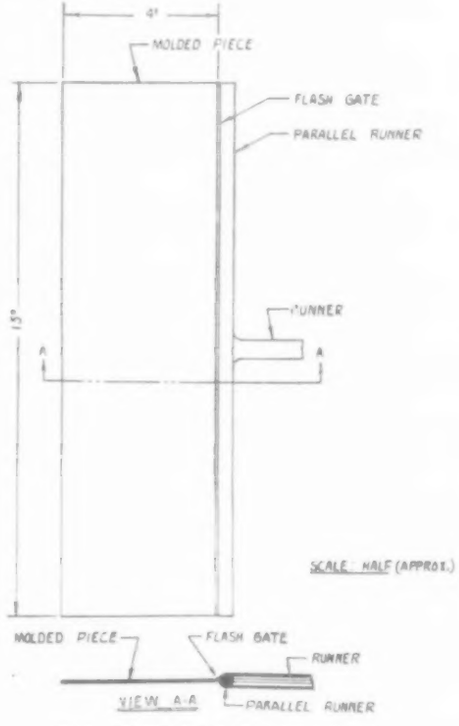
Clamp Capacity

It often happens that maximum available injection pressure cannot be used without encountering a flashing condition. If the projected area of the shot is too large for the rated clamp capacity of the machine, weigh-feeding may permit molding without flashing. If, on the other hand, flashing occurs with relatively small projected areas, i.e., 25 square inches in an 8-ounce machine, look for mold deflection or unbalanced clamping on the four corners of the mold.

An accurate way of measuring mold deflection is to insert a dial micrometer between the ejector retainer plate and the cavity support plate then watch for a swing of the pointer when the mold fills. A minus read-

(Please turn to page 51)

Figure 3. Flashgate for large area moldings.



SPEAKING OF EXTRUSION

Edited by R. D. Sackett
Technical Service Associate
Monsanto Chemical Company
Sprinfield, Massachusetts

Important Advances in Extrusion Technology

R. D. Sackett and E. H. Hankey
Monsanto Chemical Co.

THE ECONOMIC ADVANTAGES of dry blending PVC resins are well recognized within the extrusion industry. Inasmuch as quality is dependent to a large scale on proper extrusion technique considerable work has been done in recent years in furthering the technology of dry blend extrusion.

Aside from chemical and physical tests, PVC quality is generally measured by surface appearance ("fish eyes") and porosity. Fish eyes and porosity (due to air entrapment) are dependent to a large extent on dry blending conditions. Unfortunately they have an inverse relationship in that as fish eyes improve, porosity is made worse. This leaves open several avenues of approach in obtaining acceptable quality. The usual technique is to compromise dry blending conditions and extrude with a shallow flighted screw. Another method is to produce a dry blend poor for "fish eyes" but low in porosity and use a valve to improve quality. The other is to produce a dry blend good for fish eyes but high in porosity and remove the porosity by vented extrusion.

This article will discuss reasons for valved extrusion and present several improved methods of valving along with experimental data showing results of valved extrusion on PVC quality. Also discussed will be a recent development by Monsanto, in conjunction with an extruder manufacturer, on the use of valves as a means of simplifying screw design problems associated with the vented extruder.

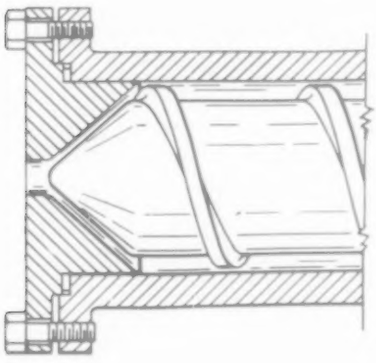
It has been known for some time that there is a direct correlation between product quality and the back pressure against which the screw operates. Increasing this back pressure moves the melt zone further back in the extruder and results in a more thorough mixing. With PVC, this will normally improve the fish eyes and the porosity problem (due to air entrapment).

In a standard extrusion setup the back pressure is determined by the shape of the extrusion die, breaker plate, screen sizes, screw design, and the viscosity of the plastic melt. Over a relatively narrow range, changes in screen packs will give increased die resistance and generally improve quality. Frequent changing of screens results in considerable loss of productivity and is a relatively crude method of controlling pressure. The precise shape of the die is dictated primarily by the shape of the article to be made and except for the length of the die land one has little control over back pressure. Thus we have a process where quality is tied in very closely with back pressure but under normal circumstances we have little control over back pressure when a wide variety of dies are used.

Where dies of large cross-sections are involved it is sometimes necessary to slow down the output rate in order to obtain acceptable quality. It was soon realized that it would be desirable to have a pressure regulating device that was independent of the die itself. In polyethylene this was no particular problem as one did not

Figure 1. (below) The "Hankey Pressure Head" for regulating extrusion pressures.

Figure 2. (right) Device to regular pressure while operating.



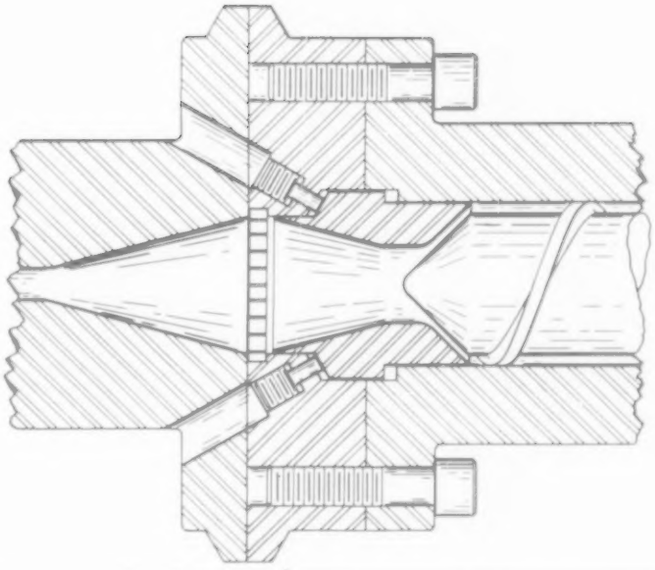
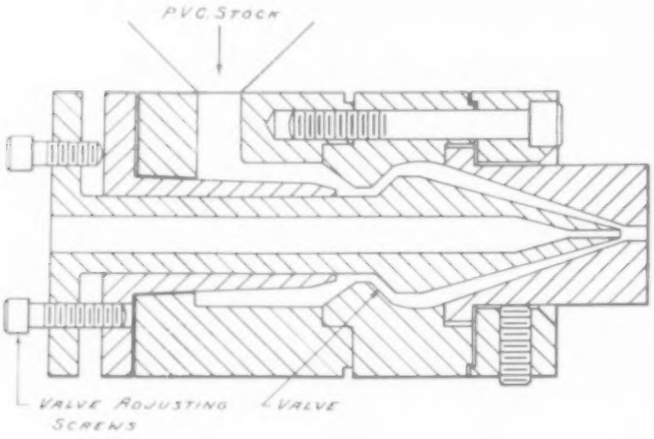
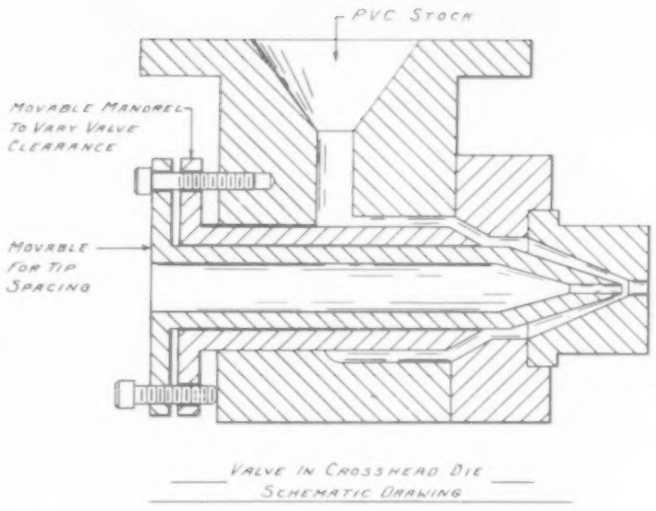


Figure 3. (below) As valve is closed, tip spacing is changed.
Figure 4. (right) Valve control without change of tip spacing.





need to be overly concerned with resin decomposition. In PVC, due to its heat sensitivity, greater consideration had to be given to the streamlining of the die.

The desirability of a pressure regulating device was first recognized by Monsanto in 1952 resulting in the filing of a patent application on the so-called "Hankey Pressure Head" in 1953. This patent was issued in November of 1956 (U. S. 2,770, 836). The patent relates to an apparatus including an adjustable pressure head for use in the continuous extrusion of thermoplastic material.

Figure 1 shows the basic principle of the device. The variable orifice in this simple case is obtained by either moving the extruder screw in and out or by placing spacers between the pressure cup and the cylinder.

There are a great variety of mechanical means in which the principles of this patent can be attained. The use of a conically shaped cup, as described in this patent, affords a good streamlined method of regulating pressure over a relatively wide range. In those extruders where the screw can be advanced relatively easy, it is desirable to use this method of pressure control in conjunction with the pressure head. Figure 2 is a proposed method by which the "Hankey Pressure Head" can be set up for pressure regulation without shutting down the extruder. It is generally desirable to incorporate a large mesh screen with the pressure cup in order to collect any major contaminants and prevent die damage, and this has been included in Figure 2. In the suggested method, the pressure cup is adjusted by means of several set screws. The adjustment could also be accomplished by means of hydraulically operated pistons in place of the set screws. The movement of the pressure head need only be very slight as it has been shown that in most pressure regulating devices, used for this purpose, increases in pressure of significant importance occur only in the final few thousandths of movement.

Table I

Pressure	Extrusion Rate lbs./hr.	Stock Temp. °F.	Fish eyes per gram	% Porosity
450	84	350	20	1%
850	77.5	352	5	.7
1525	65.3	360	3	.2
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2½" Extruder
16-1 L/D
Metering Section Flight Depth .125"
50 RPM

Table II

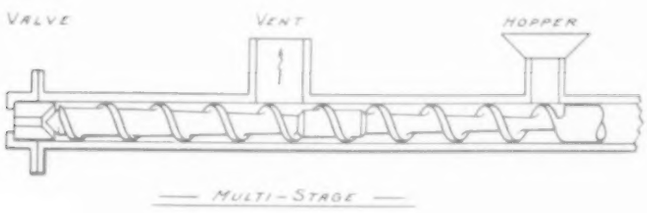
RPM	Press ps	Rate ft./min.*	Rate #/hr.	Stock Temp. °F.	Fish Eyes per gram	Surface Appearance Insulation
40	2150	318	119	360	84	NG
	2550	306	115	375	64	pass.-
	3000	221	83	385	0	good
80	1800	434	163	385	21	NG
	2500	372	140	400	0	good
	3000	313	117	415	0	good
100	2000	484	182	410	2	pass
	2500	413	155	415	0	good

2½" Extruder
20-1 L/D
Metering Section Flight Depth .172"
* #14 wire 1/32 insulation

The effect of increasing die pressure on "fish eyes" and porosity in PVC dry blends is shown in Table I. A specially prepared dry blend was selected in order to illustrate the effects of higher pressure on quality. It should be noted that there is a definite reduction in fish eyes per gram and in the percent porosity (based on specific gravity) as pressure is increased. At higher back pressure, there is also an increase in stock temperature and a reduction in output. The purpose of this test was merely to show the improvement in quality with higher pressures and no attempt was made to maintain output rates. It should be obvious, however, that by the proper adjustment of screw speed and the pressure head that improved quality can be obtained at satisfactory output rates and this will be shown later.

Valves of the general type discussed are suitable for most applications. However, in the wire industry there

Figure 5. The vented extruder.



exists a special problem. In this field the alignment of the cross-head die with the expensive (and substantially mounted) take off equipment is critical. In Figure 3 is shown a valved wire die that does not cause any realignment problem as the valve is an integral part of the cross-head.

It has been suggested that the "tip" in a wire die can be used as a valve. This has the disadvantage that the spacing between the end of the leader and the back of the die has a minimum critical position. If the leader is moved closer than this, uneven flow results and unacceptable wire is produced. As pointed out previously, pressure regulation does not occur until the valve is almost closed and in this position the tip would be too close to the die. In our experience the maximum distance back from the die (within reasonable limits) is not critical. In Figure 3 as the valve is closed the tip spacing is changed. This did not, however, cause any difficulty and very excellent valving was obtained. Results of an experimental run made with this die are shown in Table II.

Figure 4 shows a die incorporating the principles of the die covered in Figure 3 but valve control is obtained without changing the tip spacing. In this suggested design either the valve or the tip spacing can be set independently.

An important advantage of the valves described is that they do not limit output in those applications where for one reason or another valving is not required. It should be noted that there is a temperature increase as pressure is increased and if screw speed is also increased to maintain output, there may be a still further temperature problem. The ability to maintain a high level of production at high back pressure assumes either the presence of screws with high pressure developing capacities or applications and equipment where higher screw speeds are mechanically feasible. As the techniques of valved extrusion are improved there will undoubtedly be an increase in the use of this method of controlling product quality.

The vented extruder has been accepted for many years as a desirable means of removing volatiles from thermoplastics during the extrusion operation. Porosity (primarily entrapped air) in PVC wire coatings has been a problem for several years and is especially troublesome in cable jacketing applications. The vented extruder has proven itself as a satisfactory means of reducing porosity in PVC.

The acceptance of vented extrusion by the wire industry has been slow, primarily because of the requirements they place on the vented extruder to perform over a wide pressure range. It is normal in the wire industry to operate a single extruder with back pressures from 200 psi to something in the order of 2500 to 3000 psi. The problem of balancing the two stages of a vented extruder are well known. Over a reasonable pressure range this is possibly by proper screw design.

First let's review the operation of a vented extruder (Figure 5). It is essentially two screws driven along a single shaft. Venting occurs at the feed to the second screw and the pressure at this point is zero. The second stage (or screw), must be capable of operating surge free at low die pressures and yet be capable of delivering full capacity of the first stage at high die resistance. Failure to perform the latter will result in flow from the vent. It has been previously pointed out that the output of an extruder varies directly with the pressure. This is only true on a single stage extruder. In a vented extruder the output of the second stage depends on the output of the first stage and this is dependent in most cases on screw design.

Recognizing the fact that the output of a vented extruder is independent of die resistance (assuming no flow from vent) it became obvious that by using a valve the screw design problem could be simplified. In other words, it was no longer necessary to expect the screw to operate satisfactorily over a wide pressure range because the combination of the valve plus the die could always be set at the same pressure. The design pressure can be selected at the highest expected die pressure and then the screw designed to operate at this pressure. As dies with lower back pressure are used the valve can be adjusted to bring the pressure up to design level.

We have briefly outlined the salient controllable points in valved and vented extrusion. Before all problems and questions can be answered, further comprehensive development work must be carried out. Subsequent articles will be published as soon as factual information has been compiled.**

Molding Cycles . . .

(Continued from page 48)

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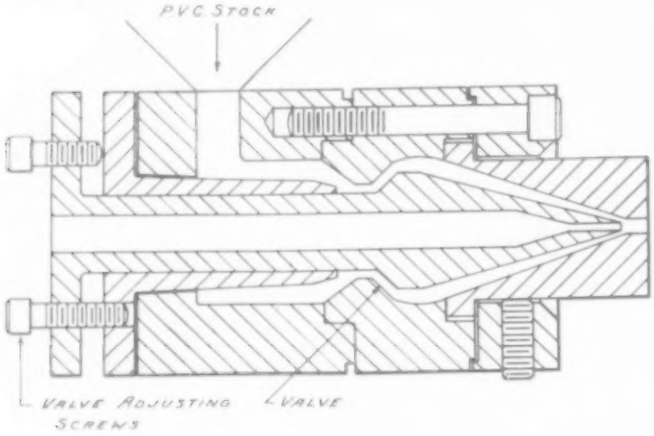

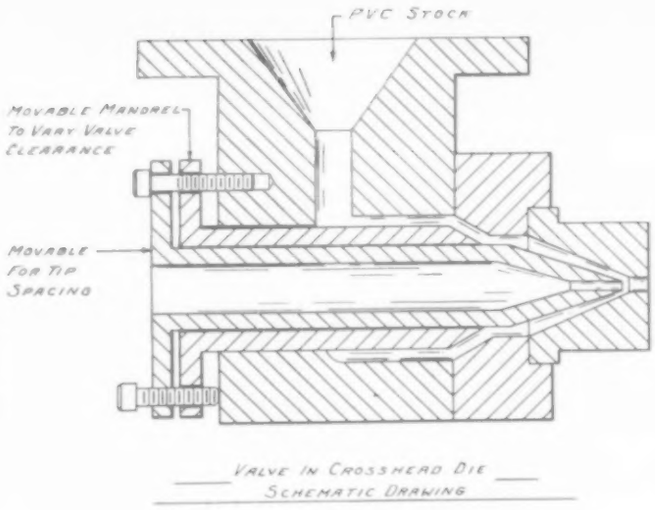

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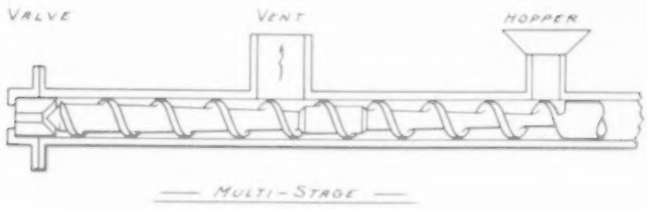

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Thin wall clear polystyrene containers are formed in this mold of CRUCIBLE CSM 2. Mold Builder: Standard Tool Company, Leominster, Mass.

they picked ultrasonically inspected

CRUCIBLE CSM 2

from warehouse stocks

FOR HIGHER FINISH . . . LONGER MOLD LIFE — It takes a highly polished and dimensionally accurate mold to form clear styrene into these thin walled containers. And, because production-runs go into the millions, the mold steel has to be long lasting. Both are good reasons why CRUCIBLE CSM 2 was selected.

For CRUCIBLE CSM 2 is an exceptionally *clean* steel—uniform in composition and structure—with superior machining and polishing characteristics. And for absolute dependability, *every piece* of CSM 2 is ultrasonically inspected.

What's more, for your convenience, CSM 2 is immediately available from Crucible *warehouse stock* in 205 sizes. Next time you need mold steel—call Crucible. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

Action— By Your National Organization

"The objects of the Society shall be to promote in all lawful ways the Arts, Sciences, and Engineering Practices and Standards connected with the utilization of plastics."

National Council Action — Oct. 10

Thomas A. Bissel is Executive Secretary

Acting on the recommendation of the Executive Committee, your National Council appointed Thomas A. Bissell as Executive Secretary of the Society, to become effective November 11, 1957.

Thomas A. Bissell

Mr. Bissell comes to the Society of Plastics Engineers, Inc. with a background of 21 years in administrative capacities with the Society of Automotive Engineers (SAE). In his latest assignment, Tom Bissell served as Manager, Meetings Division, a group charged with development and operation of 11 annual national meetings designed to serve the needs of SAE's 23,000 members. Tom Bissell received his Mechanical Engineering degree from Cornell University in 1923. After graduation, he spent six years as a design and plant engineer in industry.

A former Technical Editor for the "SAE Journal", Bissell has contributed many articles to technical publications. One of Tom's most noteworthy contributions was the article "Designing for Alternate Materials" published in the July, 1941, issue of the "SAE Journal". He is co-author of the automotive texts "Motor Vehicles and their Engines" and "Automotive Mechanics" (Van Nostrand, 1941 and 1942, respectively.)

You'll recognize Tom Bissell from his picture when you meet him at ANTEC in Detroit in January or during his visits to RETEC and the sections during 1958.

RETEC Approved.

Council approved the bid of Chicago Section for a RETEC to be held April 18, 1958 on the subject "New Developments in Plastics Molding Techniques."

Meetings Committee reported to Council that attendance for the September 27th, 1957, Buffalo RETEC on "Hot-Runner Molding" reached 200. On October 8th, approximately 180 were present in Minneapolis for the Upper Midwest Section's RETEC "Isocyanates". SPE members may order copies of the Pre-print Book covering the "Isocyanates" symposium from the National Office.

Urge your Section Officers to investigate possibilities for RETEC sponsorship by your own Section during 1958! Remember, these one-day, single subject technical meetings are sponsored by the geographical sections of the Society—National Office will provide such assistance as is requested by Section Officers.

Ad Hoc Study Committees.

Council approved President Simmons' appointments for the following ad hoc study committee chairmanships:

Committee to Revise "Section Procedures Manual"—John C. Bonnett, Quebec Section.

Commendation—

By National Council to Dr. Jesse H. Day, Editor, SPE Journal, for directing the Journal to its present position of eminence in the publication of technical papers pertaining to plastics science and engineering. Dr. Day's achievements are judged all the more remarkable because he has been editing the Journal for the past 12 years on a part-time basis.

Financial Report

Jules W. Lindau III, National Treasurer, presented financial report for the fiscal year ending June 30, 1957, and commented on the current strong position of SPE National finances. For details of our financial picture, see page 56.

Plastics Institute Committee

Jerome Formo, Upper-Midwest Section, Chairman of the Plastics Institute Committee reported on activities of his group in their study to determine feasibility of the establishment of a Plastics Institute. This committee's next step is development of a Basic Plan brochure to be presented to potential supporting groups for Plastics Institute.

January 27, 1958 National Council Meeting

National President Peter W. Simmons announced that the fifth and final meeting of the 1957 National Council will be held January 27, 1958, at Sheraton-Cadillac Hotel in Detroit, Michigan.

Attendance at the January 28-31, 1958 Annual Technical Conference in Detroit is now projected at 2600 to 2800 registrants. SPE members are urged to advance-register for this event promptly!

Sincerely,

Ken Gossett

R. K. Gossett
National Secretary

SPE 14th Technical Conference

January 28-31, 1958

The Sheraton-Cadillac Hotel, Detroit

Introducing the Session Moderators

Listed below are the outstanding plastics engineers who will moderate the sessions and preside over the lectures to be given at the 14th ANTEC in Detroit on January 28, 29, 30, 31, 1958.

Each man is well qualified to assume the leadership of the sessions under his jurisdiction and is considered an authority on the topics to be given under his supervision.

W. E. Gloor

Raymond F. Boyer

W. E. Gloor is presently working on poly-olefins and cellulose derivatives for the Hercules Powder Co. Graduated from Case School of Applied Science in 1929, he earned his Ch.E. degree in 1934. Since that time he has been with Hercules as a chemist, plastics supervisor and in development work in cellulose products. He is co-author of German Plastics Practice (1946) and Cellulose Data (1955).

Raymond F. Boyer joined the Dow Chemical Co. in 1935. He has served as chairman of the Division of Polymer Chemistry of ACS during 1956. Since 1952 he has been director of plastics research at Dow. Co-editor of the book Styrene—Its Polymers, Copolymers and Derivatives, he was awarded an honorary doctorate in 1955 by Case Institute of Technology.

C. A. Harper is presently responsible for current and developmental engineering for subject materials and processes, associated with the use of insulating materials and processes used in embedment, potting, impregnating and encapsulating applications for electrical uses for Westinghouse.

Albert A. Kaufman is president of Prodex Corp., located at Fords, N. J., manufacturers of extrusion machinery and process equipment. He has been in the plastics business in the United States for the past 19 years. His education and early employment were gained in Europe.

Robert C. Bartlett has been engaged in the manufacture and use of plastics since 1941 when he graduated from Princeton with a degree in chemical engineering. He is now chief chemist, specializing in electrical insulation, for the Natvar Corp. He is active in the Education Committee of SPE and is a director of the Newark Section of SPE.

M. J. Vietien is sales promotion manager for Paper Package Co., Indianapolis. Educated in Europe, he came to the United States in 1927. In 1945, after varied experience he became active in the development of a plastics fabricating department for Paper Package Co., where he had been since 1942. He is at present in overall charge of the plastics operations of the company.

Fred Lyijynen, supervisor of the plastics development department of Chrysler Corp., stamping division, was born in Finland, and came to the United States in 1927. He studied mechanical engineering at Wayne University in Detroit. In 1939 he was assigned to plastic development at Briggs Manufacturing, which became part of Chrysler in 1953.

C. A. Harper

Albert A. Kaufman

Robert C. Bartlett

M. J. Vietien

Fred Lyijynen

L. J. Morrison

Earl L. Kropscott

Frank W. Reinhart

L. J. Morrison is vice-president of Detroit Mold Engineering Co., a position he has held since 1944. He earned his degree in mechanical engineering at the University of Cincinnati in 1935, and has been in the plastics industry since 1937, and has engaged in making plastics dies since 1940.

Earle L. Kropscott has been manager of molding materials in the plastics department at Dow Chemical Co., since 1956. He previously spent 11 years in Dow's cellulose products laboratory and nine years as assistant manager of plastics technical service. He holds a degree in chemistry from Hope College, and an M.S. degree from New York State College of Forestry.

Frank W. Reinhart is chief of the plastics section of the National Bureau of Standards, where he directs the Bureau's research, development and testing program on plastics and adhesives. He taught chemistry at Juniata College from 1930 until he joined NBS in 1937. He received the A.S.T.M. Award of Merit in 1957, and is widely known for his activities in A.S.T.M. He is a past national president of SPE.

Hiller G. Sherwood is founder and president of Michigan Plastic Products, Inc., custom injection molders of Grand Haven, Michigan. He earned his degree in mechanical engineering at the University of Michigan in 1937. He joined Reynolds Molded Plastics in Cambridge, Ohio in 1941, and in 1946 founded his own company.

Mario J. Petretti has been active in the plastics industry since 1934. He is presently vice-president and sales manager, in charge of development and engineering of Camfield Fiberglass Plastics, Inc., Zeeland, Michigan. He is a past national president of the SPE.

Walter E. Jacobson has been with Yardley Plastics Co., since 1936, where he is now executive vice-president, and he is also an officer and director in Yardley of Canada, Puerto Rico Industrial Plastics Corp., and Canadian Moulding Ltd., an aluminum extrusion firm. He has been a member of the Central Ohio Section of SPE since its inception.

John A. Clark has served the last four years as materials engineer for the General American Transportation Corp. He has been interested in production, cost reduction, and proper selection of materials. He is active in working with material suppliers to assist the development of improved plastics materials.

James T. O'Reilly is supervisor of the non-metallics and applied physics section of the process development department at the Ford Motor Co. He is a past president of the Detroit Rubber and Plastics Group. During World War II he was made responsible for rubber and plastics control and development at the Willow Run B-24 Bomber plant.

Carl F. Massopust is director of research and development, plastics division of General American Transportation Corp., a position he has held since 1953. He earned his degree in chemical engineering at Marquette University in 1942, and has worked in the field of plastics since that time.

A. A. Pavlic is manager of plastics sales for the polychemicals department of duPont, with responsibility for marketing duPont's polyethylene, nylon, and acrylic resins. He joined duPont after being awarded his doctorate degree in chemistry in 1942 by the University of Wisconsin. He has been manager of plastics sales since 1955.

Hiller P. Sherwood

Mario J. Petretti

John A. Clark

Walter E. Jacobson

A. A. Pavlic

E. C. Fries

James T. O'Reilly

Carl F. Massopust

E. C. Fries is chief engineer of the thermoplastics division of Auburn Plastics, Inc., where he has served since 1937, starting with actual operation of production compression and injection molds. He graduated in 1937 from Bliss Electrical School, Washington, D. C.

D. A. Davis has been a plastics engineer at General Electric since 1953, currently serving in development in the chemistry laboratory of the major appliances division. His current assignment is in the field of vacuum forming and foam insulation. He is at present also finishing the work for an M.S. degree in chemistry at the University of Louisville.

Samuel H. Greenwood was recently appointed manager of the press division of F. J. Stokes Corp., Philadelphia. He has been closely associated with the plastics industry since joining Stokes in 1949. He is a graduate of Case Institute of Technology (1941).

C. N. Sprankle

Robert H. Kittner

C. N. Sprankle has been sales manager of the film and sheet division of Plax Corp., for the past six years. The preceding seven years were spent with Sandee Manufacturing, custom extruders of plastics materials, as vice president and sales manager. Earlier experience was in the product development division of Sears, Roebuck, specializing in plastics.

Robert H. Kittner is development director of Mobay Chemical Co., an affiliate company of Monsanto Chemical Co. His major field of activity is the commercial development and marketing of new chemicals and plastic products. He has held this position since 1954. He earned a degree at Case Institute of Technology in 1928, and the Ch.E. degree at Columbus in 1929.

William O. Bracken is a member of the Hi-Fax sales group of Hercules Powder Company's cellulose products department. He earned his degree in chemical engineering from Tufts College in 1936, and after other experience he joined Hercules in 1939. He is a past national president of SPE, and is a member of a number of technical societies.

Eli A. Haddad is assistant director of technical service for Monsanto Chemical Co., where he is responsible for the technical service and development activities for the plastics division. He joined Monsanto in 1943 as research chemist. He earned his degree in chemistry at Holy Cross College in 1940 and has done graduate work at M.I.T.

(Please turn to page 58)

D. A. Davis

Samuel H. Greenwood

William O. Bracken

Eli Haddad

Technical Committees Reports

Editor: Don Biklen

The Professional Activities Groups

The scope of P.A.G. is to further the progress, development, and enhancement of the Society and the industry by—

—Working to develop and disseminate engineering knowledge and technical data.

—Providing source of Technical Advisory Service.

—Helping to maintain proper balance in the activities of the Society by fostering each group's interest, working in co-operation with other society activities and committees.

All activities performed toward the accomplishment of these goals shall be in complete harmony with the objects of the Society.

In the task of organizing and activating P.A.G., we were faced with the need to:

1. Determine definition and scope of P.A.G.

2. Develop a procedures manual that would describe the organization and the method by which P.A.G. would accomplish its objectives.

3. Organize and man the eleven approved Groups, and appoint necessary Liaison and Co-ordinators.

All three of these major steps have now been accomplished. We have presented the results to the October 10th Council meeting in Kansas City and have received Council approval. Our request for By-Law changes, as described in our procedures manual, was accepted for first reading.

Listed below are the temporary chairmen of the eleven approved Groups, and the complete listing of Liaison and Co-ordinators.

Plastics In Electrical Insulation
Daniel I. Nitzberg, Hoover Electronics Co., 110 West Timonium Road, Timonium, Maryland

Compression Molding
Edward W. Vaill, Bakelite Company, 30 E. 42nd Street, New York, N.Y.

Injection Molding
Gustav G. Freygang, Rohm & Haas Co., Bristol, Pa.

Laminating
A. J. Green, 115 W. 39th Street, Wilmington, Del.

Fabricating
Clem J. Young, Crescent Plastics, Inc., 955 Diamond Ave., Evansville 7, Ind.

Metals For Plastics Mold
Charles Davis, Stokes Trenton, Inc., Box 213, Trenton 9, New Jersey

Extrusion
John H. Myers, Dev. Engr. Department, Celanese Corp., Newark 5, N.J.

Finishing
Gordon K. Storin, 3 Forest Road, Lewiston Heights, Lewiston, N.Y.

Casting (Non-Elec.)
Jerome D. Bassin, The Borden Company, 14 Johnson Street, Bainbridge, N.Y.

Forming
Lawrence Barr, Plax Corporation, P.O. Box 1019, Hartford, Conn.

Plastics In Building
Dr. Lucius Gilman, Monsanto Chemical Co., Everett Station, Boston 49, Mass.

Administrator:
George W. Martin, Holyoke Plastics Corp., 178 Sargeant Street, Holyoke, Mass.

Assistant Administrator and Education Committee Liaison:
Dr. Norman A. Skow, Synthane Corp., Oaks, Pa.

Meetings Committee Liaison:
John A. Picard, The Dow Chemical Company, Midland, Michigan

Technical Advisory Co-Ordinator:
William O. Bracken, Hercules Powder Company, Wilmington, Delaware

Publications Committee Liaison:
Donald W. Biklen, Orangeburg Mfg. Company, Orangeburg, New York

Local Section P. A. C. Liaison:
Thomas A. DeMarco, Monsanto Chemical Company, 812 Monsanto Avenue, Springfield, Mass.

Inter-Society Relations Committee Liaison:
Jerome L. Formo, Chairman, Minneapolis Honeywell Regulator Co., 2743 Fourth Avenue, S., Minneapolis 8, Minn.

SPE—ASTM D-20 Group on Plastics Standards, Liaison:
Arnold M. Varner, Chairman, R.F.D. #3, Fern Creek, Kentucky

Abstracting Advisory:
Dr. Jesse H. Day, S.P.E. Journal, Security Bank Building, Athens, Ohio

Although we feel that our basic organizational stages are complete, P.A.G. is still in its infancy, and has not as yet had an opportunity to produce real activity—that is, with the exception of our Plastics in Electrical Insulation Group. This Group had the fortunate advantage of being the original Group formed, and also the advantage of having several of the most energetic and organizationally capable men available to carry out its organization. They are now completely organized and include many task groups that are already enjoying considerable activity. You will be hearing more from this Group, as we know that you will be hearing from all of our Professional Activity Groups.

Each Group will hold its annual meeting in conjunction with Antec Detroit in January. They will, at that time, elect their permanent officers for the coming year.

Most of you are quite aware of the efforts of our Local Section Liaison Chairman toward the co-ordination (and in some cases the organization), of Local Section Professional Activity Committees. Although these Local

Antec Moderators . . . (from page 56)

Donald R. Fegley

William P. Gobeille

Donald R. Fegley is the chief engineer of Reed-Prentice Corporation.

He was employed as chief engineer of Consolidated Molded Products Corp., from 1939 to 1955 and associated with Doehler-Jarvis and Stanley G. Flagg & Company from 1933 to 1939.

William P. Gobeille attended Purdue University and graduated with a B.S. in Mechanical Engineering. In 1943 he was named Chief Planning Engineer for Ampco, Inc., a specialty bronze producer in Milwaukee, Wisconsin. He left to become Chief Engineer for Cruver Manufacturing and later was named Works Manager. He started with American Motors Corporation, predecessor Nash-Kelvinator, in 1948 and now manages the Plastics Division.

Technical Committee Reports (from page 57)

Committees are not actually a part of P.A.G., we hope to achieve a well coordinated PAG/PAC combined program of activities.

One of the important "fringe benefits" that we have enjoyed is in the many new S.P.E. Members that we can truly attribute to P.A.G. We feel that P.A.G. will quickly become a real and worthwhile factor in the membership area of S.P.E. One of the requisites of joining P.A.G. of course, is first being a member of S.P.E.

Technical Advisory service is available, through our good T.A. Co-ordinator, for all who wish to forward requests. "Bill" Bracken is continuing to handle this activity in his usual highly efficient manner.

In the not too distant future, we look forward to the reality of all phases of our Society being able to turn to P.A.G. for assistance, both advisory and actual.

Each of our Group Chairmen is very hard at work completing his Group organization, including task groups, and individual scope. They will welcome volunteer members to their Groups. If you would like to participate in this very worthwhile activity, contact the chairman of the Group of your choice. We would suggest that you contact him directly at the address shown in the preceding listing.

If perchance, the particular area of your interest is not represented in any of these eleven Groups, you may petition for another Group by forwarding a petition signed by ten members. Please forward any such petition to the attention of this Administrator for proper handling and action.

Each Section President and National Director has a copy of our P.A.G. procedures manual. We are certain that you will find these available to you to further acquaint yourself with the Professional Activity Groups.

We will look forward to welcoming you to what we feel is to become one of the most active and worthwhile segments of our great Society of Plastics Engineers.

George W. Martin
P.A.G. Administrator

Annual Financial Statement of the Society of Plastics Engineers

July 27, 1957

The Society of Plastics Engineers, Inc.
34 East Putnam Avenue
Greenwich, Connecticut

. . . I have examined the books and records of The Society of Plastics Engineers, Inc. for the period July 1, 1956 through June 30, 1957 and found them maintained in accordance with accepted accounting principles applied on a basis consistent with that of the preceding year, with the exception of capital expenditures which were charged off in the fiscal year in which they were purchased.

Respectfully submitted,
Bruce Gordon
Public Accountant

THE SOCIETY OF PLASTICS ENGINEERS, INC.

STATEMENT OF ASSETS AND LIABILITIES

AS AT JUNE 30, 1957

ASSETS			
Current Assets			
Cash—First National Bank	$29,127.14		
Petty Cash	76.93		
Total Operation Cash		$29,204.07	
Cash Reserved—First Federal Savings and Loan		11,115.70	
Cash Reserved—The Seamen's Bank for Savings		10,880.40	
Advances—1958 Conference		2,168.45	
Accounts Receivable—Advertisers		546.98	
Inventory—Books and SPE Journals		5,977.10	
Total Current Assets			$59,892.71
Capital Assets			
Furniture and Fixtures			1.00
Prepaid Items			2,181.46
TOTAL ASSETS			62,075.17
LIABILITIES AND SURPLUS			
Current Liabilities			
Accounts Payable—Sections	2,182.24		
Accounts Payable and Accrued Expenses	3,856.67		
Payroll Taxes Payable	649.63		
Total Current Liabilities			6,688.54
Deferred Income			
1957 Conference			9,454.31
Reserves			
Contingency—(Seamen's Bank for Savings Contra)	10,880.40		
Research (First Federal Savings and Loan Contra)	11,115.70		
Total Reserves			21,966.10
Surplus—Per Exhibit "C"			23,936.22
TOTAL LIABILITIES AND SURPLUS			62,075.17

NEWS of the industry

Whitlock Incorporates

C. H. Whitlock Associates was recently incorporated and are now known as Whitlock Associates, Inc. President is C. H. Whitlock, Vice-president is Mary G. Denny, and Secretary is Richard Denny.

Four Marlex Melt Indices

Marlex 50 resin, Phillips rigid polyethylene, is now available in four melt indices, it was announced today by Phillips Chemical Co., a subsidiary of the Phillips Petroleum Co.

With the new range of melt indices, the applications of Marlex 50 polyethylene, already being used in the textile, drug, housewares, industrial, and other fields, is enormously expanded.

All four types of the improved plastic retain the original Marlex 50 qualities of heat resistance, rigidity, and purity. The new advance means that processing time can be sharply reduced and that for the first time large molded items can be produced.

Licensing Wanted

Plastics manufacturers at Oyonnax, France, are seeking through their association novel American or Canadian products which they would like to make and sell in France under a licensing arrangement.

The French manufacturers are especially interested in plastic products such as novel packaging (boxes, wrappings, etc.) for confections, toiletries and similar items; novel household articles and gadgets; toys; advertising and promotion items.

Such items could not be imported into France because of the present foreign exchange restrictions, but the French government permits payments of royalties in dollar currency and thereby offers an opportunity to American or Canadian manufacturers and patent holders to replace this export loss by a profitable income from licensing arrangements.

Offers and inquiries may be directed to the Council on Public Relations, Inc., 366 Madison Avenue, New York, the representatives of the Oyonnax association in the United States and Canada.

Fostarene Representative

The re-appointment of H. Muehlstein & Company, Inc. as national sales representatives for the full line of Fostarene polystyrene has been announced by Joseph C. Foster, president of Foster Grant Co., Inc., Leominster, Massachusetts, producers of Fostarene.

Regional Plants

The first step in the establishment of nation-wide regional plants, each with full manufacturing and processing facilities, to service molders and extruders has been taken by Plastic Materials, Inc. of Hicksville, Long Island, N. Y.

Mr Herbert Preiss, president of the company, has announced the opening of a Chicago plant and has indicated plans for new regional operations in other territories.

Mr. Chris J. Runfola, vice-president, will head the new plant.

Blue Epoxy

A blue epoxy resin compound, recently developed by Smooth-On Manufacturing Co. 572 Communipaw Avenue, Jersey City, N. J., has been specifically formulated for use in hand lamination systems where surface hardness and resistance to abrasion are essential. Sonite SC-2 has sufficient thixotropy for application as a heavy brush coat, without sagging, on a vertical surface.

Revolutionary Electrode

Aetna Electronic Corporation of Carle Place, L.I., New York, announces a revolutionary electrode that simplifies the treating of polyethylene film by bombarding the surface with scientifically controlled electrons. This electronic treater can be conveniently mounted on any type of extruder to produce treated film in one simple operation. Simply set the single knob remote control and this precision electrode treats film uniformly in any gauge, widths to 66 inches, in strips or overall.

For further information, contact: Herbert Margrill Advertising, 60 West 46th Street, New York, 16, N.Y. Phone CIrcle 6-9221.

Hirtz Moves

Walter E. Hirtz Plastics Materials, Inc. has moved to larger quarters at 13916 Garvey Blvd., Baldwin Park, California. Walter E. Hirtz Plastics Materials, Inc. is a dealer and processor of all types of thermoplastics scrap in reground or unground form, such as Polyethylene, Polystyrene, Butyrate, Cellulose Acetate, Ethocel, Nylon, Methyl Methacrylate (Lucite and Plexiglas), Vinyl, etc. This company also buys surplus lots of virgin molding powders.

Polyethylenes

A revealing discussion entitled "What About The New Polyethylenes" highlights the current issue of the Plastics Weldor and Fabricator, external house organ of the American Agile Corporation, Maple Heights (Cleveland), Ohio.

This feature article details the advantages and expected applications for the new high density polyethylenes and illustrates two of the already proven industrial uses.

The Fabricator, which is now published nine times per year, also includes an illustrated article on the use of polyethylene floats to cut evaporation in plating room operations. A new feature, "The Agile Laboratory Reports On....." this month covers the important subject of stress cracking of polyethylene.

Copies may be obtained from the American Agile Corporation, P. O. Box 168, Bedford, Ohio.

Plaskon Products

Products made of Plaskon urea, melamine and alkyd molding compounds and Plaskon nylon molding and extrusion compounds are listed and illustrated and outstanding properties which make each molding compound ideal for these specific applications are briefly described. Designated P-95, the folder is offered by Barrett Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6.

Men In The News

Herbert J. Cronin

The Great American Plastics Company of Nashua, New Hampshire announces the appointment of Mr. Herbert J. Cronin, Jr. as sales manager of their chemical division which is located in Fitchburg, Massachusetts. This division produces polyvinyl chloride resin. Mr. Cronin will assume his duties on September 30th. Mr. Cronin was formerly associated with the Dow Chemical Company.

Peter N. Triano

Peter N. Triano has joined Interplastics Corporation as Sales Representative, as announced by Gerald F. Bamberger, President.

Interplastics Corporation, located at 120 East 56th Street, New York 22, N. Y., supplies a complete line of thermoplastics molding powders, resins and raw materials, both for the domestic and overseas plastics industry. Interplastics Corporation also purchases surplus inventories of molding powders and plastic scrap.

"Pete" Triano, who is particularly well-known to plastic manufacturers in New Jersey and Pennsylvania, is the latest addition to the growing staff of Sales and Service Representatives of Interplastics Corporation.

AROUND THE WORLD

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UNITED STATES

ELECTRICAL MANUFACTURING

September, 1957

Abstracter: Bennet Nathanson

Isocyanate-Resin-Coated Elastomeric Insulation — *Herbert G. Steffens, Natvar Corp., Woodridge, N. J.*

An improved isocyanate-resin-coated electrical insulation, introduced in 1956, has now been made available in an elastomeric form. Available as sleeving and tape, this new material offers advantages of flexibility while retaining original high levels of physical and dielectric properties. This elastomeric isocyanate coating can stand applications requiring continuous performance at temperatures up to approximately 150°C. It retains many of the desirable characteristics of the original isocyanate-resin-coated insulation such as high abrasion resistance, superior adhesion to glass, oil resistance, solvent resistance, high dielectric strength, plus improved extensibility. The manufacture and process for this elastomeric isocyanate produces a polymer highly resistant to solvents and able to withstand the hydrolizing action of boiling water and steam.

Evaluation Tests for Epoxy Casting Systems — *Mark V. Goodyear, James P. Hornburg, Houghton Laboratories, Olean, New York*

Selection of an optimum casting resin system for specific applications requires qualitative test data on service performance under increasingly higher temperatures. A heat aging test method described in this article is used to obtain such data; it is also useful for screening raw materials for the resin systems. Performance of various systems is compared.

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MECHANICAL ENGINEERING

August, 1957

Abstracter: Philip G. Fleming

Plastics and Rubbers — *Wyman Goss*

Mr. Goss presents a summary of properties and important applications of various plastic materials commonly used in the automotive industry. The nuclear vulcanization of polyethylene is briefly discussed. Several unreferenced tables and figures presenting some properties of randomly-chosen materials are included.

Coatings and Finishes — J. H. Reindl

This article provides a comprehensive, impartial guide to coatings selected from currently available materials, as well as methods of application. The author classifies coatings, or finishes, for engineering materials as organic, metallic and conversion types.

Note: This article is general in scope and would make good reference for general information or discussion purposes.

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CANADA

CANADIAN PLASTICS

August, 1957

Abstracter: Harriman H. Dash

Plastics Creates A New Industry

The adhesive industry is discussed in the light of the newer contributions made by the plastics industry. The employment of condensation polymers has created many new applications not previously possible with older natural materials such as starch, rubber, and protein glues. The condensation polymers discussed are primarily those of phenolic, urea, and melamine formaldehydes. Industries using these resin adhesives range from paper and plywood to metals. Where low cost is a factor the resin adhesives still face competition from the natural products, but where higher and quality performance is desired only an adhesive based on synthetic resins fits the bill. Vinyls (acetates and acetals), acrylics, epoxies, and silicones are also briefly discussed. The acetates make inexpensive binders for a variety of fillers. Epoxy formulations are listed as examples of specialty adhesives. Metal bond strengths up to 6400 psi are possible. Silicones have recently been finding uses in pressure sensitive adhesives.

3M of Canada

Plastics constitute one of the major portions of 3M's activities. The company started out as a mining venture with little success, but switched to manufacturing with a large and varied growth. Versatility of products is a great asset to the company. Specialty products are adhesives and tapes. The company's products and their applications are briefly discussed, including a variety of plastics and also some non-plastic operations.

Polyvinyl Alcohol Disproves Old Adage — *John H. Foley*

The use of PVAL film for vacuum and pressure bag techniques is discussed. This is employed in the reinforced industry to replace expensive dies and molds. The film is unaffected by most substances, except water. Reynolds PVAL sheet is claimed to withstand pressures in excess of 105 psi and temperatures up to 500°F. Diagrams illustrating its application are included in the article.

A Review and Preview of the Injection Molding Industry — *A. Reynolds Morse*

The author reports a number of developments on the negative side of the business. These include the absence of new business starts, the reduction in the number of big presses (in the 400 oz. range), and the rapid obsolescence of machinery. The reduction in large presses has been due to the inroads made by low pressure reinforced plastics and vacuum forming. To offset these difficulties, there have been a number of positive features such as the rapid growth of the custom and captive molders. There have been few failures among established molders. Progress in materials and machinery is discussed. Technical details of press speed, gating, sprues, nozzles, etc. are covered in the article. Many molders have been salvaging obsolete 8 oz. machines by converting to 4 oz. machines with rapid and automatic cycles.

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FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

July, August, 1957

Abstracter: Hans Mayer

Teflon as antiadherent — *Gard Besson*

Of the various methods of applica-

tion of Teflon as an antiadherent on metallic surfaces, the dispersion method is the only one in practical use.

After the metal surface has been thoroughly degreased, an acid dispersion is applied and after drying subjected to elevated temperatures. After this, a number of coats of neutral dispersions are applied, each coat being thoroughly dried before the following application. The resulting surface consists of pure Teflon.

The advantages of this process application on molds, rollers, mixing bowls, etc. are described.

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ITALY
POLIPLASTI
May, June, 1957
Abstracter: Alfred L. Alk

Treatment of Phenolic Laminates with Transformer Oil — *Giorgio Ughetto*

The author prepared laminates of kraft or cloth with several phenolic resins; subjected the cured samples to physical testing before and after immersion for varying periods at 85°C. Results are discussed and tabulated. Tests and preparation details are presented.

Fundamental Characteristics and technology of Polytetrafluoroethylene — *Elvio Fachinelli*

A thorough review of PTFE, its properties, manufacture and fabrication techniques.

The Chemistry of Unsaturated Polyester Resins — *Paolo Bonardi*

Polyesters are described and examples of the several types are explained chemically. Further discussion follows under the headings: Raw Materials Used in the Preparation of unsaturated Polyester Resins; Typical Preparation of a Catalyzed Polyester Resin; Inhibitors of Unsaturated Polyesters; Catalysts; Accelerators.

Plastics in the Army and Navy — *Clemente Ronconi*

A discussion of the present scope of plastics in the Italian military services and reports and suggestions on increasing the quantity and quality of such use through closer communication between the industry and officialdom.

Centrifugally Cast Glass Reinforced Polyester Pipe — *Giorgio Anglesio and Manlio Muzzoli*

Polyester pipe has some particular advantages over other plastics and metals as well as such disadvantages as higher cost, lack of bendability in the field, loss of strength under certain difficult operating conditions. Six or seven American firms are now producing polyester pipe and expectations are for 200,000 tons of such piping to be required by the oil industry alone. The best method of pipe production is by wrapping a mandrel in one way or another. However, the Reflin Company produces pipe by centrifugally casting, producing a pipe with a glossy exterior, smooth but uneven interior, freedom from porosity and with a very favorable glass to resin ratio. Most pipe is free from filler and is usually prepared from glass mat or rovings to get maximum even distribution of glass fibres.

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GERMANY
KUNSTSTOFFE
August, 1957
Abstracter: Anne Schwend

Petro-Chemistry and Plastics Industry — *Winnacker*

A survey on the history and future development possibilities of plastics derived from crude oil.

Influencing the Properties of Plastics by Irradiation — *M. Magat*

A survey on to-day's status of possibilities to induce the formation of radicals, polymerization and graft polymerization, cross-linking and decomposition by high energy radiation.

Recent Physical Test Methods for Plastics — *Jan Koppelmann*

It has been recognized that technological one-point measurements insufficiently characterize the mechanical attitude of plastics. Materials will react differently in long-term tests than under brief peak loads. Hence, dynamic test methods were developed and mechanical/dynamic methods are compared with dynamic di-electrical ones. Dynamic methods have proven particularly useful for loads of less than one second duration. Dynamic di-electric and mechanical test methods permit deep-reaching insight into molecular relaxation processes which is of great importance for the interpretation of physical properties of the plastics under investigation.

Vulcanization Methods for Silicone Caoutchouc—*S. Nitzsche and M. Wick*

The vulcanization of silicone caoutchouc with peroxides, sulphur, thru irradiation and condensing multifunctional siloxanes is discussed. Attempts to use cold-vulcanizing silicone caoutchoucs together with gas-releasing agents has been crowned with success recently, making it possible to produce expanded silicone caoutchouc in the cold way, a product which certainly offers interesting vistas.

Extruding Polyethylene Films and Sheeting — *E. C. Bernhardt*

The essential parts of extrusion equipment for polyethylene such as the extruder itself, the nozzle, cooling and take-up equipment are separately discussed as to design details, as previously discussed in U. S. journals.

Extrusion of Thermoplastic High Polymers — *Karl Tanner*

An introduction into the essentials of plastification and the melting process is followed by a confrontation of heat transfer problems, i.e. by convection or friction. Preference is still given to customary convection heating due to several disadvantages of frictional heating such as the near impossibility for vents. Further, the possibility of regulating the pressure via the influence of temperature or the viscosity of the mass is investigated. Inherent problems were solved by Messrs. Leistritz and their extruder LSP 120 which uses just one type of screw for all kinds of material being extruded.

Improved Stabilizing Systems for PVC Products — *Emery Parker*

A release by Advance Solvents and Chemical Corp., New York, and the Deutsche Advance Produktion GmbH. at Cologne. An explanation of processes and reactions as seen by various sources of literature is followed by an investigation of the stabilizing effect of organo/tin compounds and metallic soaps. In spite of extensive empirical experience it was impossible to find a satisfactory theory for the stabilization mechanism of different metals. Hence, the infra-red spectrum of plasticizer-free suspension PVC films was analyzed. Evidently only a cadmium compound showed color impeding effects, while barium and especially tin intensify the color. Such tests shall be extended also to co-polymers as well as 2-metal-systems. It is hoped to find a scientific explanation for the hitherto indefinite term of synergistic effects. There are enough factors known to date to presume that a chemical reaction between stabilizer and resin is the reason for the effects of metallic stabilizers on PVC. A report on tests with model substances resembling PVC shall be released shortly.

Methods of Production for Plastic Foams, Considering Expanding Agents in Particular — *H. A. Scheurlen*

Typical examples for the three basic ways of producing plastic foams

a. Mixing (Dunlop and Talalay methods)
b. Physical and
c. Chemical expansion of plastics

are described and followed by a close look at the nature and processing properties of expanding agents used.

Glass Fibre Reinforcements for Plastics—Problems and Developments — *Oskar Meyer*

A survey of recent developments in the United States in the field of plastics reinforcement by glass fibres supplemented by German experiences and developments.

Ethoxylen as Binder for Glass Fibre Reinforced Plastics — *R. Stierli*

The two to three times higher price of ethoxylen versus polyester has been an impediment towards their vast application as binders for glass fibre reinforced plastics so far, a fact which will surely be reversed in the future due to advantages offered: excellent binding qualities for glass and metal reinforcements, absence of delamination tendencies upon vibrations and strong impacts, low shrinkage upon hardening, low internal stresses, low water absorption, high resistance against chemicals, in particular alkalies, outspokenly good electrical properties, increased mechanical resistance against pressure and impacts, odor- and flavorless, high elongation when combined with glass fibers or inorganic fillers, excellent pot life of resins, properties which are discussed under the aspect of glass fibre reinforced ethoxylen resins.

Injection Molding Machines Working with Screws — *Hans Beck*

Temperature distribution in molding cylinders of normal design may best be described by isothermal curves. A longitudinal section thru the cylinder shows them as parabolic curves, a cross section as concentric circles. The mass of material to be molded, hence, always shows heterogeneous temperatures which are highest next to the cylinder walls as well as the nozzle and decrease in the direction of the axis of the cylinder and with increasing distance from the cylinder walls. Although many attempts were made to remedy the situation by special cylinder designs, these basic deficiencies could not be overcome and appear so much more the higher the volume per shot and the molding temperature are. Pre-plasticizing, although helping with some problems, does present others such as sufficient sealing of the injection ram. German Patent No. 858310 describes an injection ram with the shape of a screw which is driven forward and backward in addition to rotational movements, the cylinder for which is free from any inserts causing localization of heat and impeding free flow. The pressure generated by rotation as well as by the forward/backward motion of the screw is used as molding pressure. Any safety precautions against back flow such as back pressure valves, are rendered superfluous. The characteristics of such screw injection molding machines are:

a. Heating of plastic masses constantly in motion
b. Considerable reduction of loss of pressure in the cylinder
c. Lower pressure gradient in the sprue as well as the mold cavities
d. Lower maximum pressure needed for filling cavities
e. Constant volume per shot independent of kind of materials molded
f. Simplified timing
g. Features of extruders such as homogenization of dry blends or compatible but only pre-mixed materials, etc. may be adopted
h. Greater freedom with respect to shape and execution of injection molded articles as well as increase in the choice of materials that may be molded.

While Messrs. R. H. Windsor introduced an injection molding machine with two screws, Ankerwerk Gebr. Goller of Nuremberg introduced a one-screw injection molding machine. Some test results are discussed.

Thermal Reactions upon Processing of Thermosetting Plastics — *C. M. von Meysenbug*

Although empirically known, extensive tests were conducted to stipulate the exact reactions and conversion processes taking place upon heating of thermosetting plastics which result in the demand for heating with the shortest delay possible for which high frequency appears to be most suitable. Measuring the specific heat showed that the condensation process is shifted to higher temperatures if heating-up is accelerated which helps the good flow of materials also in complicated molds. The coefficient of thermal conductivity increases with higher density and higher temperatures. Hence, the best heat transfer in thermosetting plastics is obtained when tabletting and rapid heating-up.

The Whirl-Clad Process — Developments and Recent Findings — *E. Gemmer*

The whirl-clad process for high and low pressure polyethylene, polyacrylates, polyamides and plastic compounds on the basis of thermosetting resins is described. Apparatuses developed for different kinds of application are discussed.

Influence of Processing Techniques on the Properties of Injection Molded Parts — *Hans Volland*

The German Technical Committee for technical injection molded parts has worked out a questionnaire giving the processor a good survey on the properties a molded technical part should show thus making it possible for them to choose the appropriate raw material. This questionnaire and problems arising in connection therewith are discussed.

Welding and Cementing of Acrylic Glass — *F. Esser*

Bonding of polymethacrylate parts or polymethacrylate with other plastics, metal or wood by means of thermal welding, with solvents, lacquers or polymerizable cements is discussed. Although the work involved by polymerizable cements is higher, the finish and appearance of parts thus treated compensates for the extra expenditure in addition to higher strength and better resistance to weather influences and chemicals obtainable. Newly developed cold hardening polymerizable cements are therefore preferred for joining polymethacrylate parts. Bonding to other materials presents problems with respect to the varying coefficient of expansion, but there are a number of possibilities to get durable joints, chances which are discussed.

Experiences in Bonding Recently Developed Plastics — *Otto Jordan*

The bonding possibilities and means for polyamides, polyurethanes, polyfluorocarbons, silicone caoutchouc, as well as polycarbonates and terephthalic acid glycolate ester are surveyed, partly with reference to U.S. literature. It is expected that techniques applied to-day will suffer changes in several cases since simplifications and improvements may result from developments still under way.

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KUNSTSTOFF-RUNDSCHAU

June, 1957

Abstracter: Leo Fischer

Anionic Polymerization of Caprolactam — *J. Sebenda*

Polymerization of caprolactam is a reversible reaction. To prevent depolymerization an alkali carbonate is used as catalyst, such as sodium carbonate. The system must, however, be kept completely free of water. The reaction is somewhat as follows: the carbonate anion reacts with the amide group of the caprolactam as a result of a breakoff of carbon dioxide, thus forming a strongly basic amino anion. This reaction is followed by the instantaneous neutralization of the amino anion through the relatively acid hydroxyl group.

Practical Applications of High Molecular Ester Plasticizers — *Dr. K. Zohrer and Dr. A. Merz*

This article discusses the characteristics of low and high molecular weight esterified plasticizers, their behavior in solution, and the comparative behavior in various resins. These plasticizers have the following advantages over ordinary plasticizers; less bleeding, better resistance to solvent extraction, less migration, good aging. Their disadvantage is usually high viscosity, and poor resistance to extreme cold. A plasticizer P-204, a German proprietory product, (an adipic acid) is compared with DOP and other plasticizers.

A table gives the tolerances of various vinyl, cellulosic and synthetic rubbers to sebacates, adipates and phthalic as well as epoxy plasticizers. Another table gives a list of all the sebasic plasticizers made in the world

today, their trade names, manufacturers, and countries. It is suggested that these high molecular weight plasticizers be warmed before milling, that pigments be combined in the plasticizers in three-roll mills, and that very high milling temperatures be used.

It is often desirable to combine plasticizers incompatible with each other. This may be done by milling one at a time with PVC and then combining the plasticized stocks. It is also suggested that Banbury or W & P mixers not be used with epoxy plasticizers. Extrusion or direct milling seems to be much better.

Plastic Foams — *K. H. Krauser (Iceland)*

This article is a comprehensive survey of all the foam plastics as now produced. Discussed are the following foams: PVC, isocyanates, polystyrene, phenol, microballoons, silicone, epoxy, cellulose acetate, polyvinlyacetate, polyamids, polyethylene, polytetrafluorethylene, acrylic.

Styrolized Oils and Alkyd Resins — *Dr. M. Bottcher*

This first installment of the article is concerned with the patent literature relating to the use of styrene, both in the monomeric and polymer form, in copolymerization with oils and alkyds chiefly for the paint industry. The patent literature covered is international in scope.

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DER PLASTVERARBEITER

July, 1957

Abstracter: Leo Fischer

Introduction to a Theory of Dielectric Heating — *J. Linke*

The basic principles of dielectric heating are quite complex although the mechanism is relatively simple. Atoms arranged at random unsymmetrically, when brought under the influence of a foreign electrical field are turned in one direction toward the energized field. If the atoms are such that they become neutralized, then the material to be sealed acquires polar characteristics. The negative electrons are gravitated toward the positive pole, and the nucleus itself is subjected to a force in the opposite direction. This deformation of the atom raises the electric potential and the atom takes on polar characteristics. The polarity of a substance in a dielectric system between the two platens of a condenser defines the value of the dielectric constant. Under the influence of a changeable energy factor, a dipole changes from a low energy field to a higher energy field and thus absorbs energy. If the reverse takes place energy is released. Since the greatest part of the released energy is in the thermal spectrum, the explanation of the warming of a thermoplastic is thus clear. Thus two factors play a part in dielectric heating—the dielectric constant, and the energy loss factor.

This issue contains a series of articles concerned with modern packaging of food stuffs and practically all other retail merchandise. All known plastic packaging films are discussed and evaluated. One article discusses corrosion resistant packaging; another pressure sensitive adhesives in packaging. Electronic sealing and automatic machinery are also covered.

Business Report of the Plastics Industry 1956 — *German Society of Plastics Manufacturers*

This report gives a general picture of the status of the German plastics industry and its relation to other German industry. A 600% growth since 1936 is second in growth only to the petrochemical industry. The chief headache for the plastics industry seems to be lack of long term credits and capital for expansion and research. This is especially so for the smaller companies. The report comments on the great deal of foreign capital entering the German plastics industry. The year 1956 seems to indicate a static situation in the plastics business. In some fields an actual setback has taken place. During 1956 the plastics industry has worked 84% of capacity, 20% of which was exported.

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GREAT BRITAIN

PLASTICS

July, 1957

Abstracter: Alfred Rexer

The British Plastics Exhibition

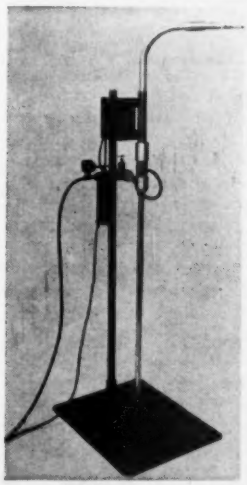
Extensive coverage is given in this issue to the first plastics exhibition to be held in Great Britain in which overseas companies are participating.

Synthetic Rubber—S. E. Bolam

This article explains why synthetic rubber manufacture has come about in Great Britain; describes the various types available and how they differ from the natural product.

The Coloration of Plastics by Irradiation—Part 2 — S. H. Pinner and A. J. Swallow

The second part of this article stresses the possible applications of irradiated plastics. The permanent changes have greatest commercial scope and fall into two categories; those where the color change is intrinsically valued for patterning or for decorative purposes and those where the color change is used as an indicator of the uniformity of the radiation treatment where such is required for other purposes.



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SECTION NEWS

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New York

Evaluation Of Published Test Data

Chas. Courtney Orr

Nearly 150 members and guests attended the September 18 meeting of SPE's New York section, held at the Governor Clinton Hotel in New York City. Monte Levin served as moderator of the program whose theme was "Published Technical Data—It it Worth The Paper It's Printed On?" A vacuum-forming subgroup meeting was held concurrently in an adjoining room.

James P. Fogerty, polymer chemicals division, W. R. Grace & Co., spoke on "The Use of Physical Test Data For Design Purposes," reviewing the commonly published test data available in trade journals and company literature. He defined the properties of raw materials as falling into three groups including; those inherent in the material; those effected by the processor; and properties for which no suitable test methods are available. Touching briefly on the first two groups, he outlined the inherent and variable characteristics of raw materials, and went on to suggest that such data be considered as a relative, rather than absolute, point of departure. In the third category, Mr. Fogerty stressed the necessity for developing tests that would determine the efficiency of a material in end use applications. He stated that the development of these tests should be everyone's responsibility, and pointed out that some of the best methods along these lines have come from fabricators rather than raw material producers.

E. E. Merrill, Dow Chemical Co., discussing "Testing of Polystyrene, Polyethylene, and Cellulosics," maintained that literature presented by raw material suppliers is a valuable aid to fabricators. Many bulletins describe proper fabrication, coloring, machining, and finishing techniques and contain test data that is a definite necessity in advising customers of the best material for a given application.

W. Ward, American Cyanamid Co., spoke on "Testing of Urea, Melamine, and Phenolics," and stated that a data sheet is valuable if it describes a material without conveying any misapprehension. He pointed out that as industry progresses literature should become more informative and test data should be tabulated in maximum and minimum values. While most test data are obtained from carefully prepared specifications, values that are useful in one type of fabrication are not necessarily valid for another. The fabricator should not expect too much from his data sheet and should be ready to substitute his own craftsmanship and experience at that point beyond which the published information cannot go.

C. K. Shaw, Jr., Shaw-Randall Co., Inc., addressed the vacuum forming sub-group meeting on "Machines for Vacuum Forming." He discussed packaging in general with emphasis on blister packaging techniques, and indicated that the trend in equipment for this type operation is toward small plate machines operating at higher speeds. Trapped air forming was discussed, and economical heat sealing methods were described.

Kansas City

Tooling Problems In Injection Molding

K. A. Kaufmann

The September meeting of the Kansas City Section took place on the evening of September 18 at Wolferman's Restaurant on the Plaza. This was the first meeting to take place on the Wednesday following the third Tuesday of the month. The reason for the new schedule is to allow closer program cooperation with the St. Louis and Denver Sections. It is now possible for one speaker to give the same talk in St. Louis on Tuesday, Kansas City on Wednesday and Denver on Thursday.

Mr. Nels Taylor, Service Engineer, of Eastman Chemical Company was the main speaker of the evening. His topic was "Tooling Problems in Injection Molding". Mr. Taylor referred mainly to polyethylene and cellulosics in this informative and well presented talk. Usually, Eastman has found, these resins are not well adapted to the use of hot runner molding practices because of decomposition in the hot runners and the problem of heat transfer to the cavities.

Mr. Taylor suggested the use of nozzle heaters, particularly for cellulosics, and stressed the necessity for dry molding powder. He showed a removable tip nozzle which facilitates cleaning. Preferred runner design is full round or trapezoidal. Gating methods were also discussed. Heavy section moldings through the use of "slug-molding"—insertion of a once molded piece as an insert to be covered by a shot of additional material—was a very interesting part of Mr. Taylor's talk.

A brief discussion of extrusion die design gave excellent specific recommendations for both cellulosic sheeting and polyethylene coating. Mr. Taylor's talk was very well received by a turn out of almost fifty people to this meeting.

Syracuse

Plastics — Past, Present And Future

Anthony Falcone, Jr.

The organizational meeting of the Society of Plastic Engineers for the formation of a Syracuse Chapter, held October 3, was a tremendous success. Attendance exceeded expectations with an overflow crowd of 46 people. This made it necessary to hold the meeting in a larger room.

The new chapter was fortunate to have as guest speakers, Mr. Joseph Healey, Eastern District Director of S.P.E., and Mr. Thomas DeMarco, Industrial Applications Manager, Monsanto Chemical Co. Mr. Healey outlined the purpose of the society and noted that Syracuse will be the 38th chapter. Mr. DeMarco, whose subject was "Plastics—Past, Present and Future," gave a short history on the development of plastics and a very optimistic view for the future, showing slides of the all plastic home built by his company.

The Syracuse chapter plans to hold meetings once a month and invite speakers from the various fields of plastics. Acting chairman for the local chapter is Mr. James R. Lampman of the General Electric Co.

Philadelphia

Practical Hot Runner Molds

Ernest G. Schwab

A large crowd turned out for the first meeting of the fall season which was held, as usual, in the Lecture Hall of Franklin Institute, 20th & Parkway, Philadelphia, on September 24. Prior to the meeting, those in attendance enjoyed an excellent dinner in the Franklin Room of the Institute.

President Carl Jepson opened the meeting and the Program Committee Chairman, Mr. Ed Fitzpatrick, introduced the speaker, Mr. Joseph Grinier of Protective Closures Company, Buffalo, New York, who gave a very interesting and informative talk on the subject, "Practical Hot Runner Molds." Protective Closures Company, manufacturers of "CaPlugs," spent several years developing hot runner molding. They have operated molds successfully with polyethylene of different densities, with cellulose acetate butyrate and with polystyrene. Work has also been done with vinyl parts, although somewhat different techniques were required.

Mr. Grinier told how hot runner molding offers several advantages such as: elimination of scrap handling, slight increase of plastifying capacity, automation and more uniform material shrinkage from different cavities. It was pointed out that a pressure measuring device could easily be installed in the mold to determine the effective pressure of the melted plastic at the gate.

Mr. Grinier, throughout his discussion, endeavored to give concrete information on how to build hot runner molds. He added that while these molds are relatively easy to build and to operate, good, accurate workmanship is necessary. The successful mold depends on the proper balance among several factors. It must have adequate heat available to the runner system. There must be proper insulation between the runner system and the cavities. Also, sufficient cooling is necessary.

Mr. Grinier extended an invitation to everyone present interested in hot runner molding to visit their Buffalo Plant and see the molds in operation. He also indicated he would be most willing to assist individuals who contact him on the design of hot runner molds and hot runner molding.

Ed Blair, President of Via-Plastics and Secretary-Treasurer of S.P.I., gave a report on how he represented the Society of the Plastics Industry and instigated a further investigation into the cause of a tragic automobile fire that claimed the lives of two small children in Philadelphia on August 14.

Originally, the plastic seat covers were blamed for the blaze but due to Ed's untiring efforts in collecting information and supplying it to the proper authorities, the Police Crime Laboratory was convinced that the plastic seat covers were not capable of generating the intense flame as first believed.

The case was officially closed after the Philadelphia "Evening Bulletin" carried a fresh story absolving the plastic covers as the cause of the fire and thereby preventing any harm that might have come to the plastics industry. We, in the Philadelphia section, as well as the plastics industry in general, are all grateful to Ed for a job well done.

Toledo

Molders And Moldmakers

R. E. Dunham

On September 18, 1957, the Toledo Section enjoyed a fine talk on the relationship between moldmakers and molders, given by Mr. Ernie Csaszar, of the Newark Die Company. The talk followed an enjoyable dinner at the Plantation Inn near Toledo, attended by about thirty members and guests.

Mr. Csaszar first outlined the steps in building a mold. He listed the following: quoting, designing by moldmakers, approval of drawings, scheduling, responsibilities, and approval of the finished mold. Highlights of discussions on various points can be emphasized by elaborating on three items; quotation forms, moldmakers knowledge, and responsibilities.

Quotation forms should be filled out by the molder, and such items as knockout pins, gates, trademarks, parting lines, cooling lines, fit in the press, molding compounds, cavity numbers, delivery, etc., should be listed. The speaker emphasized that agreements on important points and some minor items before a mold is started will prevent many problems later.

Mr. Csaszar feels a moldmaker should have a thorough knowledge of molding techniques and of plastic molding materials. He advocates moldmakers attend meetings, be on mailing lists for up-to-date literature on plastics, secure publications, have close cooperation with customers, and attend educational courses, if available. An outstanding course of the sort he had in mind is offered by the Newark College of Engineering.

A chart illustrating moldmaker and molder's responsibilities was presented. The speaker balanced the moldmaker's techniques against the molder's molding techniques, smooth mechanical function with molder's part design, specific performance of a mold with molder's knowledge of material, and moldmaker's workmanship with the press used by the molder.

A lively discussion, in which the speaker participated, followed the talk.

The president announced the death this past summer of two of the outstanding members of the Section; Mr. Conrad Jobst, and Mr. William G. Skutch.

New members received in September are Robert T. Wallace, Paul Doucette, and Brent Clark.

Necrology

WILLIAM G. SKUTCH

The Toledo Section of SPE lost an outstanding member on August 13, 1957, when Mr. William G. Skutch, President of Peerless Molded Plastics, died suddenly, at the age of 66.

Mr. Skutch became closely associated with plastics in the early 30's when he became interested in the manufacture of bottle closures from plastics. After being instrumental in establishing what is now the Closure and Plastics Division of the Owens-Illinois Glass Company, he founded Peerless Molded Plastics, Inc., in Toledo, Ohio in 1938.

As the Plastics Industry expanded, Bill Skutch enlarged the operations of his company, and his interests in the molding of new items representing new applications for plastics grew with the expansions. The growth of his company exemplifies that Bill Skutch was an individual who has had much to do with making the plastics industry what it is today. Through his efforts, he was instrumental in making Peerless a successful molding shop which turns out many molded items used by everyone.

Along with his efforts in the business world, Bill Skutch was very interested in seeing that proper information of benefit to companies in the plastics business was made available so there would be a common basis of establishing and disseminating information in the industry.

He was one of the founders of the Society of Plastics Engineers and met with those associated in plastics in the Toledo and Detroit areas, prior to the Society's conception. A result of these meetings was the common feeling that a society such as SPE was needed. He was instrumental in the establishment of the Toledo Section. Mr. Skutch has also been a firm believer and has been active in the Society of Plastics Industry and that for which it stands.

Mr. Skutch is survived by his wife, Doris; sons William G., Jr. and Lawrence; and a brother, Sidney.

Pioneer Valley

Ditolyethane Process, High Flow Styrenes Discussed At Styrene Night

William E. Olson

Thursday evening, September 12, was styrene night at Wachusett Country Club as the Pioneer Valley Section got the new fall season underway. Ray Mazur, president of Western New England Section, and Sydney Lohman, president of Rhode Island-South Eastern Massachusetts Section, were present for the kick-off.

Jim Melchore, American Cyanamid Co., told of the methods of manufacture of methylstyrene and the advantages of the ditolyethane process. Comparisons were made with this type of polymethylstyrene and regular styrene. The main advantages are a lower specific gravity and outstanding heat resistance. The chemical resistance, impact strength and flexural strength are at least equal.

Because of the higher heat distortion temperatures, polymethylstyrene is stiffer than general purpose styrene, however, because the flow properties are similar, the stiffness is overcome by merely increasing the molding temperatures.

Comparisons between methylstyrene-acrylonitrile copolymer and styrene-acrylonitrile copolymer again show the methylstyrene product to have a 25°F. advantage in heat distortion, shrinkage, and cold flow. Slides dramatizing laboratory tests and showing examples of product applications were shown.

John Kent, Monsanto Chemical Co., explained where high-flow styrene materials fit into modern molding and claimed that today's speed and economies were made possible, not only by newer materials but also by faster molding equipment. General purpose polystyrene is given greater moldability by the addition of an internal plasticizer which lowers the melt viscosity, and by external lubrication which aids the flow properties in the unheated sections of the cylinder. High-flow materials utilize a higher degree of internal plasticizer than regular styrene. The distortion temperatures are lowered by the internal plasticizer as this comparison between the types of styrene shows:

S—165-172
M—176-183
R—183-190
H—192-202.

Faster molding materials would have been useless without faster machines. Faster cycles are accomplished with machines with shorter rams, larger pumps and motors. In 1950, a 16-oz. machine was marketed with a 30 HP motor and a 42 RPN. Today, a 2-3 oz. machine can be purchased with a 30 HP motor and a 60 RPN. A 1-3-oz. can be obtained with a 30 HP motor and a 70 RPN.

The reasons for faster molding material and equipment are economic. High-flow materials are not a substitute for good scrap control and machine maintenance. As an example, one drop of oil every second amounts to 20 gallons per year at a cost of $278 and requires a 1,980% makeup.

R. I. and S. E. Mass.

Vacuum Forming's Growing Impact

Glenn A. Tanner

The first meeting of the 1957-1958 season of the Rhode Island and Southeastern Massachusetts Section was held on October 3rd, at Wayland Manor in Providence with Mr. John R. Kent of Monsanto Chemical Co. speaking on Vacuum Forming.

After dinner, President Sydney Lohman of Lester Phoenix, Inc., opened the meeting and presented to the 55 members present the officers who will be in charge for the remainder of the year. These included Mr. Charles Chrones of Hassenfeld Brothers, Inc. —Vice President, and Mr. Howard Amster of Reliance Molded Plastics, Inc.—Secretary and Treasurer. Mr. Lohman also pointed up the excellent program planned for the year, including the forth-coming Christmas party to be held during the month of December.

The speaker of the evening, Mr. John R. Kent, Technical Service Department, Styrene Molding Materials of Monsanto Chemical Co. was assisted by the dean of the Monsanto Chemical Co. salesmen, Mr. Robert Johnson, in presenting his talk on "Vacuum Forming and Its Growing Impact on the Plastic Field" and also in presenting a new film on the "Importance of chemicals in our modern lives."

Mr. Kent traced the recent rapid rise in vacuum forming process in the plastics industry, but pointed out that actually the process is old for it does not differ too much from the old pressure forming system. The appeal, of course, in the vacuum forming field is the simplicity of the process which leads ultimately to its many advantages. Since the process involves only forming a heated sheet under pressure, the capital for equipment and tools is relatively small compared with other operations of the industry. He also pointed out that the time required for tooling was somewhat less and that changes in tooling are accomplished somewhat more easily. This does make it ideal for prototype and market development work.

Quite interestingly, he pointed out that the solution of the problems in the extrusion field has been the key to the success in the vacuum forming applications. This is due to the fact that today we have available a wider variety of sheet materials and, due to excellent extrusion processes, these have been made available at relatively inexpensive costs. Today, also, the equipment for vacuum forming is much improved over equipment which was available some years ago, when it was customary to use infra red lights or fiberglass blankets and to drape the material over a plaster of paris mold.

From this equipment, industry has now grown to vastly improved heating methods for the sheets, multistation machines, two-side heating of sheets with strip heaters, and the use of new techniques, including plug assists and air slip methods. To explain these various methods, he included slides of these various new machines and pointed out the relative merits of them and the processes they represented.

Mr. Kent concluded with a display of various samples of items which had been produced by the vacuum forming method and a discussion of the types of materials and the methods used to produce these items.

Milwaukee

Future Market Outlook For Plastics Industry

James S. Hearons

The September meeting of the Milwaukee Section was held Tuesday, September 10, at the Stratford Hotel at 6 p.m., dinner included. About 50 members and guests attended.

The meeting was opened with a short business discussion by Vice-President Tom Hardeman and notes on future meetings by Herb Goeden, Program Chairman. Monthly meetings are held on the second Tuesday of each month, normally at the Stratford Hotel.

As the opening talk after the summer vacation, George Stein of A. O. Smith Corporation discussed the future of plastics and the market outlook. All were quite impressed with the tremendous growth industry with which we are connected.

The second speaker of the evening was Ross Dean, Sales Manager for Sterling Incorporated and on Saturdays a Big Ten football referee. Ross discussed Big Ten Football in 1957 and showed a film on "Highlights of the 1956 Season". His presentation was most interesting and the questioning that followed gave the crowd a closer insight into what really goes on down on the field.

U. S. Delegation to ISO/TC 61 Meeting on Plastics, Burgenstock, Switzerland, July 8-13. Left to Right: N. A. Skow (Society of Plastics Engineers) director of research, Synthane Corporation, Oaks, Pa.; G. M. Kline, chief of the Division of Organic and Fibrous Materials, U. S. Bureau of Standards; R. K. Witt, Associate Professor of Chemical Engineering, John Hopkins University, Baltimore; Robert Burns, executive secretary, Materials Advisory Board, National Academy of Sciences, Washington, D. C.; C. Howard Adams, manager, Plastic Product Development Research and Engineering Division, Monsanto Chemical Company, St. Louis; E. Y. Wolford, manager, Plastics Technical Service, Koppers Company, Inc., Chemical Division, Pittsburgh; Paul E. Willard, research director, Ohio-Apex Division, Food Machinery and Chemical Corporation, Nitro, West Virginia; and A. C. Webber, research supervisor, E. I. du Pont de Nemours and Company, Experiment Station, Wilmington, Del.

Binghamton

What's Going On In Plastics Today?

L. N. Chellis

The Binghamton Section held its September meeting at the Carlton Hotel on Thursday, September 26. Sixty-eight members attended, and they were joined for this meeting by thirty-four members of the Southern Tier Technical Society.

After an excellent dinner, the combined group was privileged to hear Mr. R. L. Van Boskirk, Senior Editor of MODERN PLASTICS, speak on the subject, "What's Going on in Plastics Today?"

Mr. Van Boskirk forecasts a big future for Du Pont's Delrin. The one major drawback seems to be its flamability. Price should be very interesting when full production is achieved, since Delrin is based on formaldehyde at $.10 to $.11 a pound.

General Electric's Polycarbonate (Lexon) seems to be characterized by retention of strength under load. Semi-commercial quantities are still not available.

Molded methacrylate monomer (which is actually a combination of polymer and monomer) is an interesting new development. It may be used as a slurry for reinforced plastic.

Rotational molding of rigid plastisols, polypropylene with perhaps 10% higher heat resistance than linear polyethylene, development of stereo—specific (isotactic) polymers and medium density polyethylene are fields where rapid growth is anticipated. Rigid PVC film, unplasticized, is available in Germany, in one to two mil thicknesses.

An interesting question and answer session followed Mr. Van Boskirk's formal presentation.

Two of our members, Max Huff and Leo Pranitis of Endicott Johnson Corporation, are currently touring seven countries of Europe to visit various shoe and rubber plants.

East. New England

Hi-Speed Molding

Charles Pechulis

The 1957-1958 season of the Eastern New England Section of the Society of Plastics Engineers, Inc. opened with a meeting held at the Hotel Beacon sfield in Boston, Mass. on September 19, 1957.

Mr. David Towler, President, announced that the combined meetings of the Boston-Providence Chapter of the Society of the Plastics Industry and the Eastern New England Section of the Society of Plastics Engineers will no longer be held together, except on special occasions. Mr. John Adamitis, President of the Boston-Providence Chapter of the S.P.I., elaborated on the merits of this change.

Mr. William Nissen, Chairman of the Program Committee, introduced the first speaker, Mr. Bennet Nathanson of the Monsanto Chemical Company, who spoke on high-speed molding and showed slides, showing the effects to be had when using materials with preplasticizers.

The next speaker, Mr. Robert F. Fehr of the Watson-Stillman Press Division, spoke on the need of preplasticizers in order to obtain high-speed injection molding. He also showed slides of various mold designs, including hot-runner molds.

An open forum followed the speakers.

Connecticut

Automatic Molding

T. M. Hamilton

A good meal, fifty-seven plastic-minded friends plus a most interesting speaker kicked off the Connecticut Section's fall and winter season.

The day of Friday, September 13 may or may not have been a lucky one. However, all who attended considered the evening a most fortunate one. It was our privilege to have as our guests Mr. L. A. Ulmschneider, project engineer, and Mr. John Volertson, assistant project engineer, of Eastman Kodak Company, Kodak Park, Rochester, New York.

By means of film we were taken to Kodak Park and looked in on automatic molding procedures on reels, cores and spools. A most informative talk by Mr. Ulmschneider resulted in numerous questions indicative of the interest in automation as related to injection molding and the lowering of part costs.

Several recommendations made by Mr. Ulmschneider applying to automatic molding should be underlined in everyone's notebook:-

Good thought out tool design—leave out "frills"—stick by good basic mold design principles—consider the tool maker—the difference between running and not is "thinking"—stay simple, not complex.

Be sure you know your problem and prove out your theories before cutting steel.

T h i n k automatic—produce automatic

It is through meetings such as this our membership roster will lengthen and our program committee is sighting high in this direction.

Speakers and Buffalo officers at the recent Buffalo RETEC on Hot Runner Molding (seated, left to right) Joseph R. Grenier, Robert W. Miller, Richard W. Miler (standing) Gordon K. Storin, John A. Kavanaugh, Ernest P. Moslo.

Western New England

Linear Polyethylenes

C. Judd Holt

Seventy-one members and thirteen guests turned out for the Oct. 2 meeting at Betty's Towne House, Agawam, Mass.

It was "Linear Polyethylene Night." Blakely R. McNeill (Fuller Brush Company) was technical chairman.

Guest speakers were C. Rex Scott, of Phillips Chemical Company, East Providence, R.I., and Theodore A. Underwood, of Standard Tool Company, Leominster, Mass.

Scott spoke on "Molding Rigid Polyethylene." He compared the properties of linear polyethylene to those of branched polyethylenes and described his company's experiences in molding it. He supported his talk with a slide presentation and circulated sample moldings among his audience.

Underwood's topic was "Molds for Rigid Polyethylene." He said that, in general, linear polyethylene may be molded in any well designed mold for styrene or branched polyethylene. But he explained how better results may be achieved by using specially designed molds.

Before the technical session got under way, Blakely R. McNeill, program chairman, announced a few program changes for future meetings. He said that the March meeting on military applications had been cancelled and that an attempt was being made to arrange a session on extrusion to replace it.

Membership chairman Lawrence W. Freeman (Plax Corporation) won the attendance prize and stayed on his feet to urge section members to help his committee in its drive for new members. The new member quota, he said, has been set at 55.

It was also announced that Alvino Aliberti (A & M Tool & Die Company) and his committee are well along on plans for the annual December dinner dance.

Newark

Mold Design

R. A. White

The initial meeting of the fall season, for the Newark Section, was held on September 11, 1957.

In discussing old business, John Lombardi, section V.P. reported on the success of the Annual Field Day, held last June. Attendance by 187 members and guests contributed to an enjoyable and successful event.

Bob Hoehn, section president, outlined plans for the forthcoming section visit to the laboratory of W. R. Grace in November. Plans were also announced for the annual Christmas party in December.

The educational program at the Newark College of Engineering was outlined by committee chairman Allen Serle. Some courses have been duplicated because of heavy enrollment.

The speaker of the evening, Ernest P. Moslo, President of Moslo Machinery Co., Cleveland, Ohio, discussed mold design for High Speed Automatic Molding. The format of the discussion was an informal one, comments and questions being received from the floor during the presentation. Mr. Moslo supplemented his discussion by presenting slides of mold design features of runnerless molding, tunnel gating and hot runner molding. Molded items were distributed for examination of the features and accomplishments utilizing these techniques.

Some personnel changes affecting section members were announced; Bill Willert appointed V.P. for Frank W. Egan & Co., Milt Sanders now located with Atlantic Plastics in Hamford Conn.; replacing Milt as Sales Representative for F. J. Stokes Corp. is Lou Puintoni; also James A. Simmon appointed sales manager of H & R Industries of Nazareth, Pa.

The meeting attended by 84 members and guests ended with the awarding of door prizes.

Miami Valley

Methylstyrenes

A. P. Young

The Miami Valley Section met at the Wishing Well Restaurant, Centerville, Ohio, on Thursday Evening, October 3, 1957. The speaker was Mr. J. A. Melchore, American Cyanamid Company. Mr. Melchore described their methylstyrene polymers.

Methylstyrene is produced by a novel process which controls the concentration of the three isomers to give polymers having high heat stability, giving moldings that withstand repeated and extended exposures up to at least 212°F. without any apparent distortion.

A copolymer of methylstyrene with acrylonitrile offers a unique combination of properties: heat resistance, toughness, and improved resistance to chemicals, crazing, and marring.

These methylstyrene polymers have been injection molded in the usual presses and molds used for polystyrene. Being heat resistant polymers, they generally require slightly higher processing temperatures; no other variations in molding are required. They have also been extruded into sheet, film, pipe, and rod.

These materials have been described in a paper presented at the thirteenth annual SPE technical conference and in an article in the SPE Journal.

Chicago

Metal Disintegration

Joseph J. Schmidt

The Chicago Section of the S.P.E. held its first meeting of the fall season September 9th, 1957 at the Western Society of Engineers. The meeting was attended by 111 members and 50 guests.

The speaker for the evening was Mr. Harold Sexauer of the Elox Corporation. The Elox Corporation manufactures equipment which is used in the disintegration of metal.

After showing a movie which explained the process and showed various operations being performed by the equipment, the speaker then enumerated the various applications of the process.

He explained that some of the advantages of the process were: 1. the extreme accuracy that could be acquired; 2. the ability to work prehardened steel, carbides and stellite materials; 3. uses in forming intricate shapes such as gears, splines, vanes, etc. Although the movie did not show many applications in the plastic field it was evident that the process could be used to great advantage in that particular field.

Cleveland-Akron

Polyethylene Symposium

Robert L. Larsen

In lieu of our regular meeting for October, Cleveland-Akron sponsored a Polyethylene Symposium, at the Carter Hotel in Cleveland on October 17th.

The topic was right and the speakers knew the subject so that all who attended benefited.

The above by way of introduction indicates that all your officers and committee chairman have really planned for this year and have worked untold hours in making this an interesting year for you. Numerous Board Meetings have been held and the program committee, headed by Bob Hershey have scheduled programs through March 1958.

Included in the schedule is the Christmas Party to be held December 13th at the Aurora Inn and another 350 are expected for this affair. November meeting will have two topics, Automatic Injection Molding and a Film on Eastman Kodak Plastics.

January the topic will be Vacuum vs. Injection Molding and February meeting will be Recent Developments in Extrusion Technology. The March meeting should be another big turn out for a plant visitation is planned for Wooster Rubber Company.

The topics selected above should be reason enough for many new faces during the next few months and of course this attendance can reflect the program that will follow. Therefore, it is always of importance to your officers to hear what you have to say about these programs. What would you like to have? Drop a card and let them know.

This is your Society and the benefits derived from it, and its growth depend on your attendance and what you have to offer in the way of suggestions and assistance in the way of helping to provide interesting meetings. Why not plan on attending now, and meet others who understand your problems? The social hour can give you a new outlook on life.—See you next month.

Helmar G. Anderson

Helmar G. Anderson, for many years a member of Western New England SPE, died suddenly August 13th at the age of 55. He joined Colt's Plastic Division in 1926 to learn plastics mold making, which was to become his life's work. In 1944 Helmar joined with his brother Clarence and the late Ed Bertsche to form ABA Tool and Die Co. near Manchester, Conn. Helmar Anderson was president of ABA at the time of his demise.

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book reviews

Polythene: The Technology and Uses of Ethylene Polymers

A. Renfrew and Phillip Morgan, Editors. Published for British Plastics in 1957 by Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E. 1, England. 567 pages, 6 guineas.

Commercial interest in polyethylene is continuing at an extraordinarily high level, so the appearance of a second book within a year discussing this versatile plastic comes as no surprise. Whereas Raff and Allison in their earlier volume (see SPE Journal, **12**, 54 (October 1956) did a commendable job of covering the literature, the editors of the present volume called in the experts. These experts, including distinguished men from both sides of the ocean, have given for the most part, critical and authoritative discussions of their various areas. As is usually the case in such a volume, some of the chapters are better than others. For example, the chapters by Haywood on Oxidation and Aging, Bunn on Molecular Structure, and Willbourn on General Mechanical Properties are particularly outstanding.

The book is divided into three parts: Part I, Manufacture and Properties with 14 chapters; Part II, Processing Techniques with 10 chapters; and Part III, Applications and Prospects with 8 chapters. Part I starts with a chapter on History written by J. C. Swallow, who since he lived it, is certainly in the best of positions to write about it. Raw Materials and Manufacturing Processes was obviously written rather hurriedly, but the chapter on Reaction Kinetics does a thorough job. The chapter on Compounding is good, while the chapter on Pigments gives surprisingly complete and specific coverage. Oxidation and Aging, Molecular Structure, Electrical Properties, General Mechanical Properties, and Chemical Properties are authoritative, well-written and contain a tremendous amount of very good material. There is no chapter on the exceedingly important subject of melt properties, although the chapter on Testing and Specifications alludes many times to the variability among polyethylenes in their flow properties, and the need for more definitive tests for measuring them. Good general discussions of Low Molecular Weight Polythene, Irradiated Polythene, and Modified Polythene complete Part I.

Under Part II, Processing Techniques, there are chapters on Extrusion Problems and Screw Design, the Extrusion of Polythene Cable Covering, the Extrusion of Tube, Rod, and Profile, the Extrusion of Tubular and Flat Polythene Film, Injection Moulding, Centrifugal Casting of Large Diameter Pipe, Paper Coating, Manufacturing Techniques for Bottle Production, Sprayed Coating, and Dip Coating. These chapters are in general well-written, and in some cases cover the subjects quite thoroughly. We would have liked to have seen fewer generalities and more quantitative data in the various chapters on extrusion, and more discussion of pressure drop and heat transfer in

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Injection Moulding. Sprayed Coatings appears to be too general, and we wonder why Dip Coating was regarded as different enough to demand a special chapter.

Part III on Applications and Prospects includes chapters on the uses of polyethylene in Cables and Other Dielectric Applications, Film Applications, Domestic, Agricultural and Industrial Piping, Chemical Plant, Household Goods, and Textile Yarns and Fabrics. All of these chapters are comprehensive and very interesting. In some places greater use of quantitative data which could be used by design engineers would have added to the value of the presentation. The final two chapters on Future Outlook in the U.K. and Future Outlook in the U.S. contain the cautious optimism that is characteristically used by people who try to predict the future. Considerable data on past production capacities and sales rates are given, and it would take a real pessimist to disagree with these authors' contention that a period of rapid growth still lies ahead.

In summary, "Polythene" is a very worthwhile book, and should be very useful to polymer scientists and plastics engineers alike.

E. E. Lewis

Manufacturing Processes

4th Edition, Myron L. Begeman, John Wiley and Sons, New York, 612 pages, $8.00.

A more descriptive title might be "Conversion and Fabricating Manufacturing Processes for Metals and Plastics". The author states in the preface that the purpose is to provide students of engineering with basic knowledge of materials and process. This the book does very well and in addition it will find a useful place on the bookshelf of the engineer in industry whether he be a product, process, manufacturing, or facilities man.

This book is easily read and its use of drawings and illustrations are sufficient to make points readily understood. It is concise, which would be expected when the wide subject range is taken into consideration.

The book can be conveniently broken into sections or divisions. After Chapter I, which is somewhat introductory definitions, Chapters II through VII cover steel. There is a chapter devoted to the subjects of foundry, patterns, casting, heat treating, and powder metallurgy. Successive chapters deal with plastics, welding, electro forming and coating, hot working, cold working, and press stampings. After a chapter on inspection, Chapters XV through XXIV cover metal working on standard machine shop equipment such as lathes, shapers, milling machines and the like. The final chapter covers abrasive wheels and grinding machines.

The real feature of the book is its condensation of the essentials of the selected subject matter into a readily understood presentation. The book is a good reference source for basic principles in many of our common manufacturing processes. This book will provide adequate references for refreshing as well as an insight into the equipment and process used.

The scope of the book is adequate to qualify it as a general study of the engineering principle and manufacturing processes used in two large industries: metals and plastics.

Plastic reference is more general in nature than is metal and is limited to brief descriptions of the main types of plastics and methods of producing them.

At the end of each chapter is a list of review ques-

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Book Reviews (con't.) . . .

tions and more importantly a reference of works used by the author which in itself offers the reader an opportunity to further inquiry. Photographs in general are good and are of modern equipment and the drawings themselves are excellent. The author has used some 200 illustrations and in addition 19 charts or tables. To do justice to this book a review should be written on each chapter as each of them represents one of America's industries.

J. C. Stansel

Epoxy Resins—Their Applications and Technology

Henry Lee and Kris Neville—(The Epoxylite Corporation, El Monte, California) McGraw-Hill Book Company, 1957, 305 pp., $8.00.

Epoxy resins are one of the major developments of the last decade in the plastics industry. These materials have found applications in such diverse fields as surface coatings, electronics, tooling, and aircraft construction. Anyone keeping abreast of developments in these fields can ill afford not to know about epoxy resins. Lee's and Neville's book is the most extensive compilation on the chemistry and technology of epoxy resins that has appeared to date. They have gathered their information largely from technical bulletins published by the principal suppliers of epoxy resins, patents, government reports, technical journals, papers presented at technical conferences and private communications.

The book is especially valuable to the plastics engineer who has to develop formulations to do specific jobs. The important factors involved in developing an epoxy formulation are discussed. Due space is devoted to the various types of hardeners that can be used: aliphatic and aromatic amines, polyamides, acid anhydrides and certain catalytic systems. Pot life, reaction exotherm, and curing conditions are considered. The purpose and practice in the use of diluents, fillers, plasticizers and flexibilizers is discussed. The last half of the book is devoted to the use of epoxy resins in casting, sealing, laminating, coating and adhesive bonding applications. The final chapter covers handling methods and safety precautions.

The book is well written and remarkably free of errors. A few minor errors were noted. For example, on page 117 Methyl Nadic Anhydride is incorrectly referred to as a "methylated maleic adduct of phthalic anhydride." On page 119 the text should read 20 hours instead of 200 hours to be consistant with figure 5-1. Epoxy resins are classified as nonflammable or self-extinguishing on page 59. The reviewer is aware of only a few self-extinguishing epoxy formulations.

Since there are differences between supposedly equivalent commercial resins it would have been helpful if the authors had indicated by name the specific resin involved in the numerous tables and figures (of which there are over 200). However this criticism is largely negated by excellent referencing. The interested person can look up the original articles listed at the end of each chapter for this proprietary information.

There has been a growing need for consolidation of information on epoxy resin chemistry and technology. This book does a commendable job of fulfilling this need and is a valuable contribution to the rapidly expanding field of epoxy resins.

Luther Bolstad

A Guide to the Literature of Chemistry

Second edition, by E. J. Crane, Austin M. Patterson and Eleanor B. Marr. xiv + 397 pages. John Wiley & Sons, New York, 1957. $9.50.

This is the second edition of the well-known book by Crane and Patterson, published in 1927; Dr. Eleanor Marr is the principal author of this edition. The book remains the most comprehensive work concerning the chemical literature.

The entire book has been rewritten, with some topics covered in an abreviated manner due to the great expansion of the literature in the past thirty years. Principal topics covered include "Books," "Periodicals," "Patents," "Government Publications," "Trade Literature," "Other Sources," "Indexes" and "Procedure in Literature Searches." The appendix contains seven sections covering literature related to chemical literature; symbols, abbreviations, and standards used in chemical literature; information about the major American and Canadian libraries; a bibliography of lists of periodicals; scientific and technical organizations; discontinued chemical publications; and dealers and publishers.

Although the book gives comprehensive coverage to the general field of chemical literature, complete coverage of a specific subject may be, of necessity, less complete. For example, the listings of books and journals concerning plastics are not complete and up-to-date. Also, the very useful journal "Current Chemical Papers" is not mentioned.

The reviewer recommends this book to anyone who has occasion to use the chemical literature; even those who have had much practice in literature searches will find much useful information. The book should also prove valuable to librarians and other persons interested in checking the adequacy of their library. As written by Dr. Crane in the Forward, "the book is moving into good hands."

Robert K. Ingham

Journal of A Scientician

Piero Modigliani, Philosophical Library, 136 pages. $3.75

Dr. Modigliani, of Modiglass Fibers, Inc., has undertaken to do what almost every engineer, scientist, ditch-digger, and automobile mechanic secretly yearns to do. He has assembled his random thoughts into a "journal", in which he discusses, philosophises, and takes mental meanderings where, as Herbert phrased it, "your fancies rove".

The result is an entertaining little book that can only be described as charming. It is certainly not a technical book, but it is for the technically minded. The chapters, for the most part, consist of only a couple of pages on a given subject, but the variety of thoughts make the whole a pleasant diversion. Imagine, if you will, a short book which encompasses such esoteric subjects as the romance of old bottles, the reinforced plastics industry, and a fancied discussion between Leonardo daVinci and Albert Einstein. Dr. Modigliani has gathered such thoughts into this journal, and he has done well. Highly recommended.

Samuel S. Oleesky

Automation: Its Purpose and Future

Magnus Pyke, Philosophical Library, 191 pages. Ten Dollars.

Dr. Pyke, in his preface, fortunately disclaims any technical knowledge of electronic computers or of automation. His dissertation confirms his preface. The discussion upon which he spends 191 pages is a repetitive, redundant, verbose trifle of wistful pomposity, interspersed with complex explanations of so-called "automated" processes that are completely extraneous to the subject at hand. Careful editing could have saved ninety percent of the paper between the covers. The paragraphs are long and rambling. In the entire book, there are but three drawings and eight inconsequential photographs.

If the reader is looking for an exercise in mental gymnastics, he will certainly enjoy the philosophical efforts of the author. If, however, the technically-minded seeker of information expects to learn something about automation from the treatise, he will have wasted both time and money.

Samuel S. Oleesky

Hydraulic Fluids . . .

(Continued from page 28)

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Challenge to Plastics . . .

(Continued from page 22)

time, he will have no other choice but to build a plastics plant.

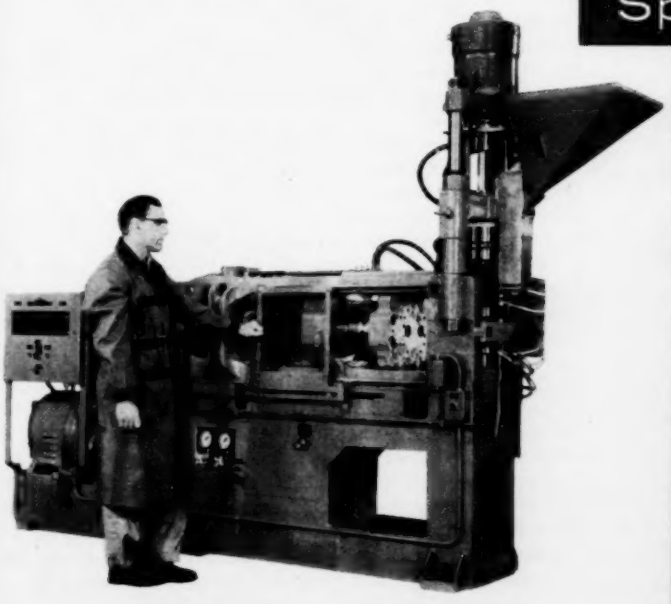
What then is the future in custom processing, in molding, fabricating, vacuum forming, and extruding?

First, is the matter of the custom processor lending his best engineering thoughts to ideas for cost reduction and new application features. Those custom processors who provide leadership in product design for cost will continue to thrive and prosper. Those who flatly accept end-user design and quote without thinking are in for a rough time.

Second, the custom supplier who automatically passes on increased costs without suggestions for redesign to keep costs down is in for trouble.

Third, failure to deliver on time, causing expensive slowdowns and stoppages on production lines, is bad business for custom enterprise.

Fourth, inspection and elimination of rejects at any stage of a continuous manufacturing process is more important than many custom enterprisers realize. A custom supplier can gain a great advantage if, when quoting on a job, he calls the purchaser's attention to absurd quality requirements which may greatly increase costs. The buyer today, more than before, must strike a balance point between the cost of production and the cost of inspection and rejection.



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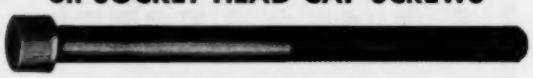

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_A NEW ERA IN PLASTICS CHEMISTRY

America's First Ziegler Polyethylene Plant

Capping a sustained 35-year program of research and development in high polymers, Hercules has brought on stream a 30-million pound plant to produce the new ethylene polymer Hi-fax. An exciting new material, Hi-fax is made by an exclusive Hercules low-pressure process employing Ziegler-type catalysts. Hi-fax has an individuality, a combination of properties all its own, which places it this minute in a class of its today.

Hercules has [illegible] chemistry since [illegible], and had its chemists studying [illegible]. In 1955, Hercules imported the first [illegible] and has since maintained a [illegible] ing.

Hi-fax, [illegible] represents a [illegible] production [illegible] final translation into [illegible] of Americ[illegible] manufacture. It opens new horizons for the plastics industry, [illegible] opportunities for [illegible]

The Significance to You of Hercules Hi-fax

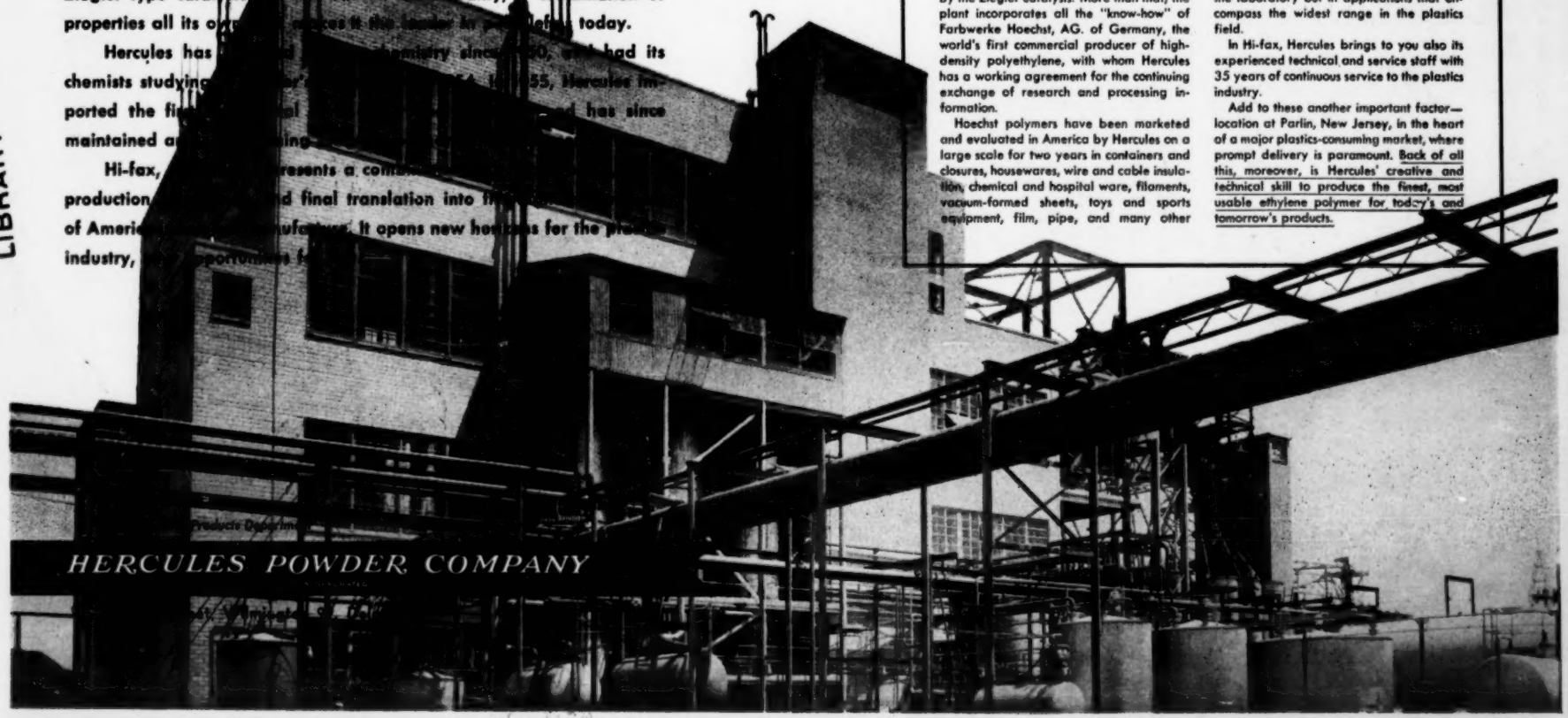
The new Hercules Hi-fax plant makes available for the first time in America a commercial plant producing proved polyethylene by the Ziegler catalysis. More than that, the plant incorporates all the "know-how" of Farbwerke Hoechst, AG. of Germany, the world's first commercial producer of high-density polyethylene, with whom Hercules has a working agreement for the continuing exchange of research and processing information.

Hoechst polymers have been marketed and evaluated in America by Hercules on a large scale for two years in containers and closures, housewares, wire and cable insulation, chemical and hospital ware, filaments, vacuum-formed sheets, toys and sports equipment, film, pipe, and many other applications.

This means that Hi-fax comes to you completely proved and established not only in the laboratory but in applications that encompass the widest range in the plastics field.

In Hi-fax, Hercules brings to you also its experienced technical and service staff with 35 years of continuous service to the plastics industry.

Add to these another important factor—location at Parlin, New Jersey, in the heart of a major plastics-consuming market, where prompt delivery is paramount. Back of all this, moreover, is Hercules' creative and technical skill to produce the finest, most usable ethylene polymer for today's and tomorrow's products.



HERCULES POWDER COMPANY

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